Materials & Methods

THE MAGAZINE OF MATERIALS ENGINEERING

The Noble Metals Are Increasingly Useful to Industry

Materials Joined by New Cold Welding Process

Metal Powder Parts Replace Those Produced by Other Methods

Close Control Required in Casting High-Conductivity Copper Alloys

Shot Blasting Replaces Pickling on Steel Cleaning Applications

New Plastics Offer Wide Range of Properties

Synthetic Sapphires Provide High Finish for Machine Parts

Materials at Work

Power Requirements for Heating Materials by Infra-Red

Maximum Temperature of Stability of Various Alloys

Metal Cleaning

Materials & Methods Manual No. 43

November 1948

FOR product engineers and designers, the unsurpassed versatility and dependable uniformity of Durez phenolic plastics offer a vast storehouse of solutions to design, structural, and production problems. An example of versatility is in impact strength. This is available in Durez compounds in a wide range to fit many applications. Emphasis on strength is obtained through manipulation in structure without undue sacrifice of heat resistance, self-insulation, surface luster, and other wanted properties.

The molded parts shown here suggest the many industrial services that *impact strength* Durez is performing. Your products may or may not require the highest degree of strength for long-life expectancy. Yet it is well to know that real ruggedness can be had with the simplicity and speed of molding.

"Durez Plastics News" can keep you advised each month of what other manufacturers are accomplishing with Durez. Let us send it to you.

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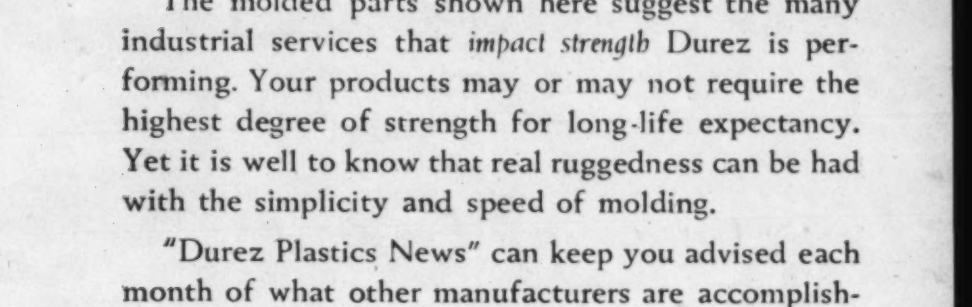
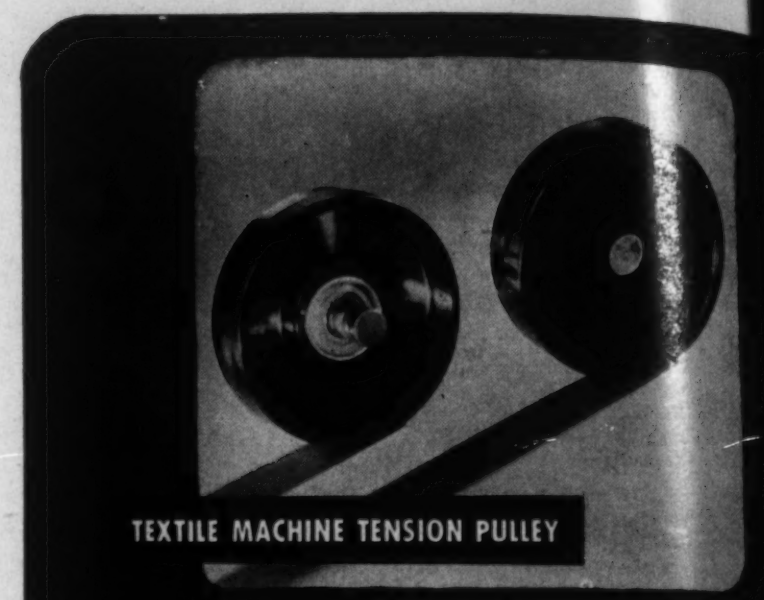
TEXTILE MACHINE tension pulley is a molded shell of medium-impact Durez, fitted with metal shields and mounted on a deep-groove metal ball bearing. Non-corrosiveness, light weight, and moldability are desirable properties that supplement the impact resistance of Durez in textile machinery.

TIRE INSPECTOR locating head serves to spot bits of metal imbedded in rubber. Self-insulation in the material is the primary requisite. Impact-resistant Durez combines this with strength needed to withstand rough service in garages.

MAGNETO PARTS requiring metal inserts are best made of a plastic material with a flexible set that will not crack around the inserts. Measuring high in all needed properties, one of the high-impact Durez compounds is widely used in this service.

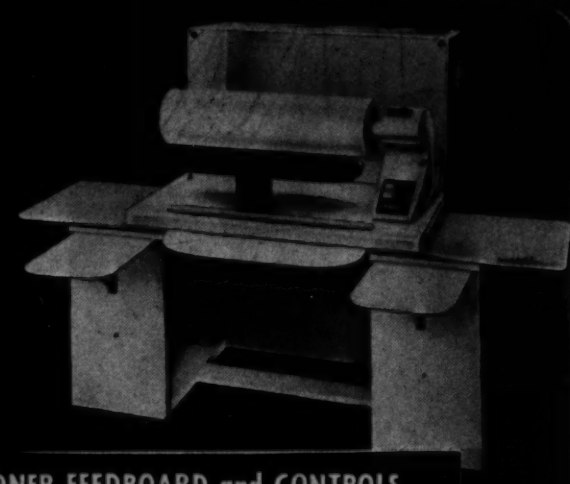
IRONER FORMING TABLE of Durez emerges from die with molded-in finish over which damp clothes will slide easily and smoothly. Impact strength of this plastic enables the table to take hard wash-day abuse. Easy moldability and dielectric properties are duplicated in the Durez thermostat dial knobs, shaft, and brackets.




TEXTILE MACHINE TENSION PULLEY

TIRE INSPECTOR LOCATING HEAD

MAGNETO PARTS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PHENOLIC PLASTICS that fit the job

Materials & Methods

VOLUME 28, NUMBER 5 • NOVEMBER, 1948®

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The MATERIALS OUTLOOK...

Ingot output booming now . . . almost 65 million tons produced in first nine months of year . . . but some rolling schedules are lagging badly. . . . Fourth quarter steel sheet and strip deliveries likely to fall 10% under third quarter figures. . . . Reason: Rising tonnage to Government-sponsored programs. . . . Current allocation-shifting puts a monkey wrench into delivery commitments more than a month ahead.

Steel exports went down to 2,457,000 tons during first half of '48 . . . 26.5% below same '47 period. . . . With a full head of steam building up in ERP boilers, Dept. of Commerce quotas call for a total third quarter shipment of 1,130,000 tons.

Detroit's taking about 15% of '48 steel production for autos and trucks . . . compared to 13.8% of last year's lower production. . . . But all signs now point to a drop in auto production in '49 . . . not more than 10% of this year's output. . . . Reason: Installment credit situation. . . . Consumer time-payment buying now tightening . . . and not all because of Regulation W. . . . Too many otherwise potential customers are already mortgaged to the hilt . . . and many more are priced out of the picture completely.

The spotlight's getting brighter on metallic titanium . . . du Pont's 100-lb. daily capacity pilot plant at Newport, Del. now producing sponge-form titanium at $5 per lb. . . . ingots are coming later. . . . Canada scheduling immediate operations at newly-surveyed titanium deposits in Quebec . . . both oxide pigment and metallic production planned . . . $250 million will be sunk in this over next few years.

Canadian aluminum development also slated to boom . . . unhindered by the power shortages, governmental interference, and restrictions that plague planning here . . . 1948 Canadian aluminum exports are double the '47 figures . . . and the throttle isn't fully opened yet.

England looking to Canada for aluminum ingot . . . it's needed to broaden production of fabricated products in the U. K. . . . Scope of British aluminum-planning much wider than here . . . inability to get regular supplies slows U. S. use.

Alcoa has jacked its price a cent a lb. on pig and ingot again . . . 99% aluminum pig is now 16¢ per lb.; ingot is 17¢. . . . Rival producers had already pushed theirs up. . . . Normally, aluminum price changes are few and far between . . . but these just ain't normal times.

Cold-rolled sheet and tinplate production boosted by opening of Columbia Steel's new mill at Pittsburg, Calif. . . . Adds about 400,000 net tons to annual West Coast supply.

But tin won't get out of the government corral right away . . . according to Washington agencies. . . . World-wide demand for tinplate continues . . . and big increases are projected. . . . Tin's still best for most food cans . . . but Government feels the mechanical industries can get along with less for bronzes, babbits and solder.

(Continued on page 4)

The Materials Outlook *(Continued)*

Labradorean ore fields getting more attention as Mesabi's deposits approach depletion. . . . If developed, ore shipments planned from fields to St. Lawrence via rail . . . thence water-shipped to N. E. area. . . . State Street Bostonians on qui vive over possibility of Hub City becoming prime steel center.

Brass and bronze coil and strip currently peddled below market values. . . . Hardware manufacturers dumping surplus production-material inventories. . . . Norwalk Lock Co. jettisons 200,000 lb. at 10% below market price. . . . Reasons: (1) Present value far above original cost; (2) demand still high; (3) change in customer preference on some hardware items.

Urea formaldehyde molding compounds get the green light. . . . "Seven-lean-year" shortage of raw materials now over. . . . Producers have long-delayed chance to catch-up on accrued orders. . . . L-O-F Plaskon Div. and American Cyanamid announce new schedules upping urea prices about 10%. . . . But 17 standard, best-selling colors will be cheaper than made-to-order hues.

Domestic mine production of bauxite is on its way to a new post-war record. . . . Arkansas mines furnishing the lion's share. . . . Imports also up; highest in history.

And speaking of bauxite . . . newly-found half-million-ton deposits in China's Fukien Province portend a larger Oriental alumina industry . . . once war-destroyed plants are rebuilt.

"Dry" metal plating, Commonwealth Engineering's newest, now possible by a gaseous medium. . . . Integral metal coatings obtained at 400 F. . . . Uniform deposition rate claimed higher than electroplating. . . . Heat is sole means of deposition . . . metal carbonyls decompose thermally in inert CO_2 atmosphere . . . plating gases recycled for economy. . . . Process exceptionally good for strip plating at high speeds.

Tissue paper handkerchiefs are now equally at home in boudoir or factory. . . . Industry-wise, they're useful for final polishing of highly finished products. . . . Advantages: Elimination of grit scratching; better absorption of grease and oil. . . . May eventually replace time-honored chamois and cotton waste.

Natural rubber imports currently exceed consumption. . . . Downhill stockpile trend halted. . . . Present world supply ample. . . . Near-future price hikes unlikely.

Carbon's coming into the backstretch and moving up fast. . . . Its recent use as blast furnace hearth-lining material satisfactory. . . . Now being considered for lining entire structures, tuyeres and mantles. . . . Claimed to outwear conventional bricking. . . . Also used in molds and to supplant brass lining in transfer boxes in continuous casting of steel.

Current scrap is poor . . . in quality and quantity. . . . The junk (literally) that's being used now would be discarded in normal times. . . . Full-page newspaper advertising campaigns now stressing need for cleaner scrap . . . better sorting of ferrous from nonferrous.

And speaking of quality, U. S. smelters often "sweeten" domestic iron ore with Swedish . . . particularly for high grade cutlery metal and such. . . . Original import figures called for 3 million tons of this superb Scandinavian ore during '48 . . . but revisions indicate only half that tonnage will arrive.

AN EDITORIAL

The Vacant Chair

Some whimsical versifier once wrote a beautiful four-line commentary on the effect of sins of omission on the human conscience:

Yesterday, upon the stair
I saw a man, who wasn't there.
He wasn't there again today—
Oh, how I wish he'd go away!

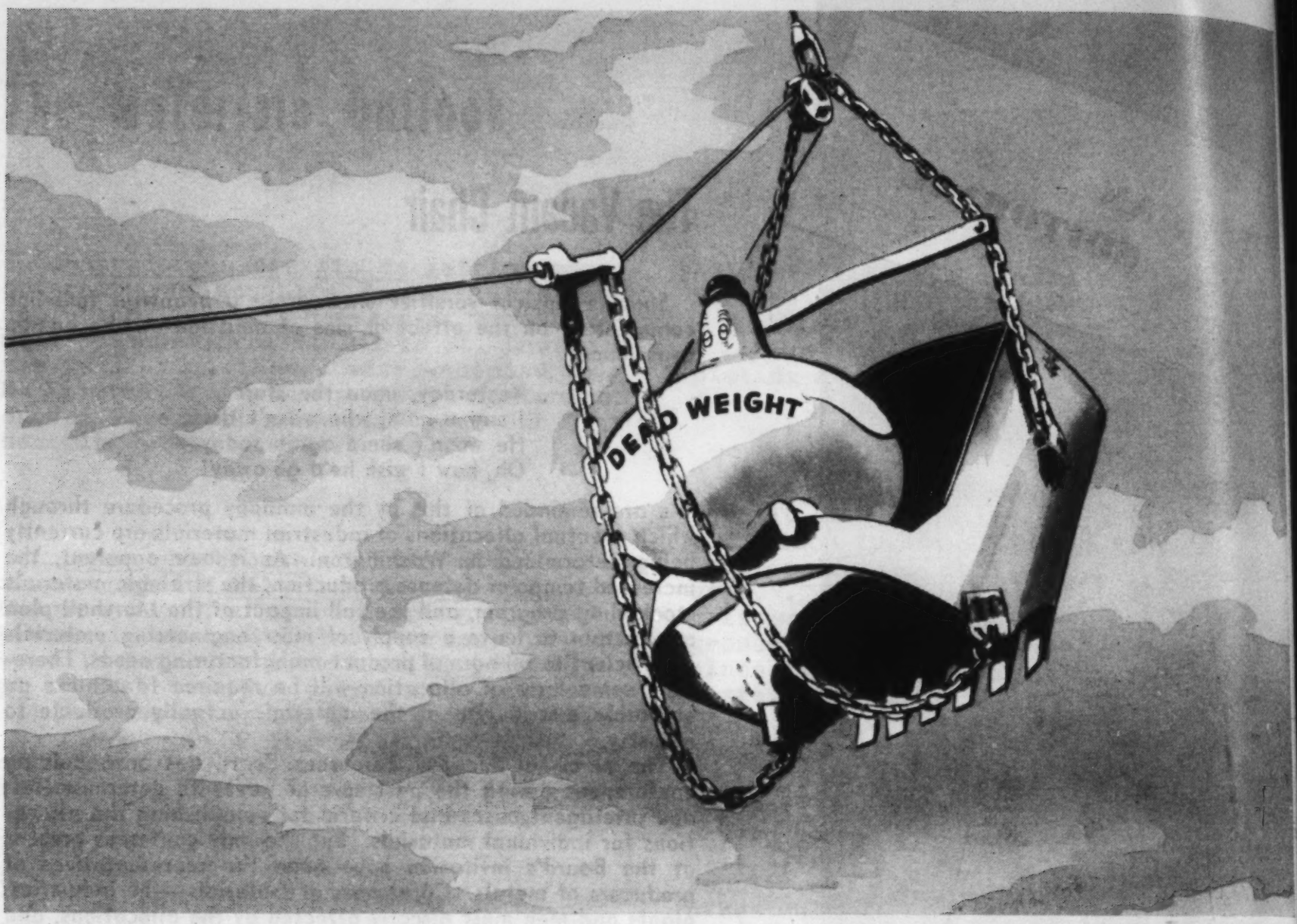
We are reminded of this by the unhappy procedure through which eventual allocations of industrial materials are currently being determined in Washington. As is now apparent, the increased tempo of defense production, the strategic materials stockpiling program, and the full impact of the Marshall plan are certain to leave a supply of most engineering materials insufficient to fill normal product-manufacturing needs. Therefore, some form of allocation will be required to achieve an equitable distribution of the materials actually available to industry.

The National Security Resources Board has been holding conferences during the past several weeks to determine fair and intelligent bases and criteria for establishing the allocations for individual materials. But the only conferees present at the Board's invitation have been the representatives of *producers* of metals. *Consumers* of materials—the industries, plants and men most directly affected by the allocations, and most intimately familiar with actual use-requirements—are not being consulted. This astonishing situation properly disturbs the producers of materials just as much as it should the rest of us, and especially as it must the neglected material-consumers.

Between 1941 and 1945 some things accomplished in the name of restrictions and allocations were more weird than wonderful, chiefly because of the hopelessly inaccurate estimates of requirements that were often made. In any forthcoming allocation period our pencils should be sharper than they were before, and fact should outshine fancy in the figures set down. The obvious way to assure this is to be certain that those who know best the country's material-requirements—the *consumers* of metals and other materials—are directly canvassed as to their actual needs.

The vacant chair at the NRCB conference table should be filled at once. Most of our readers are materials-consumers, in the present instance "the man who wasn't there." Even at the risk of hearing "Oh, how I wish he'd go away!" you should write to or call on the National Security Resources Board in Washington and seek a hearing on this question, so important not only to your own operations in the months ahead but, beyond that, to American industry and the nation as a whole.

FRED P. PETERS



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Reduce dead weight by fabricating equipment with Inland's low-alloy, high-strength HI-STEEL

If you operate load-moving equipment—freight cars, trucks, busses, excavators—you can cut costs with units made of Inland Hi-Steel. One fabricator, who switched to this amazing low-alloy steel, increased stripper bucket capacity 77%, while reducing weight 23%.

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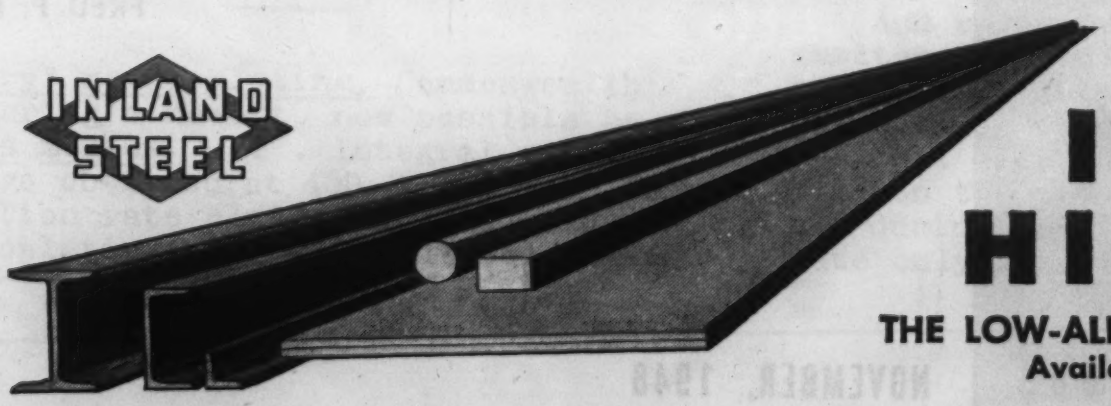

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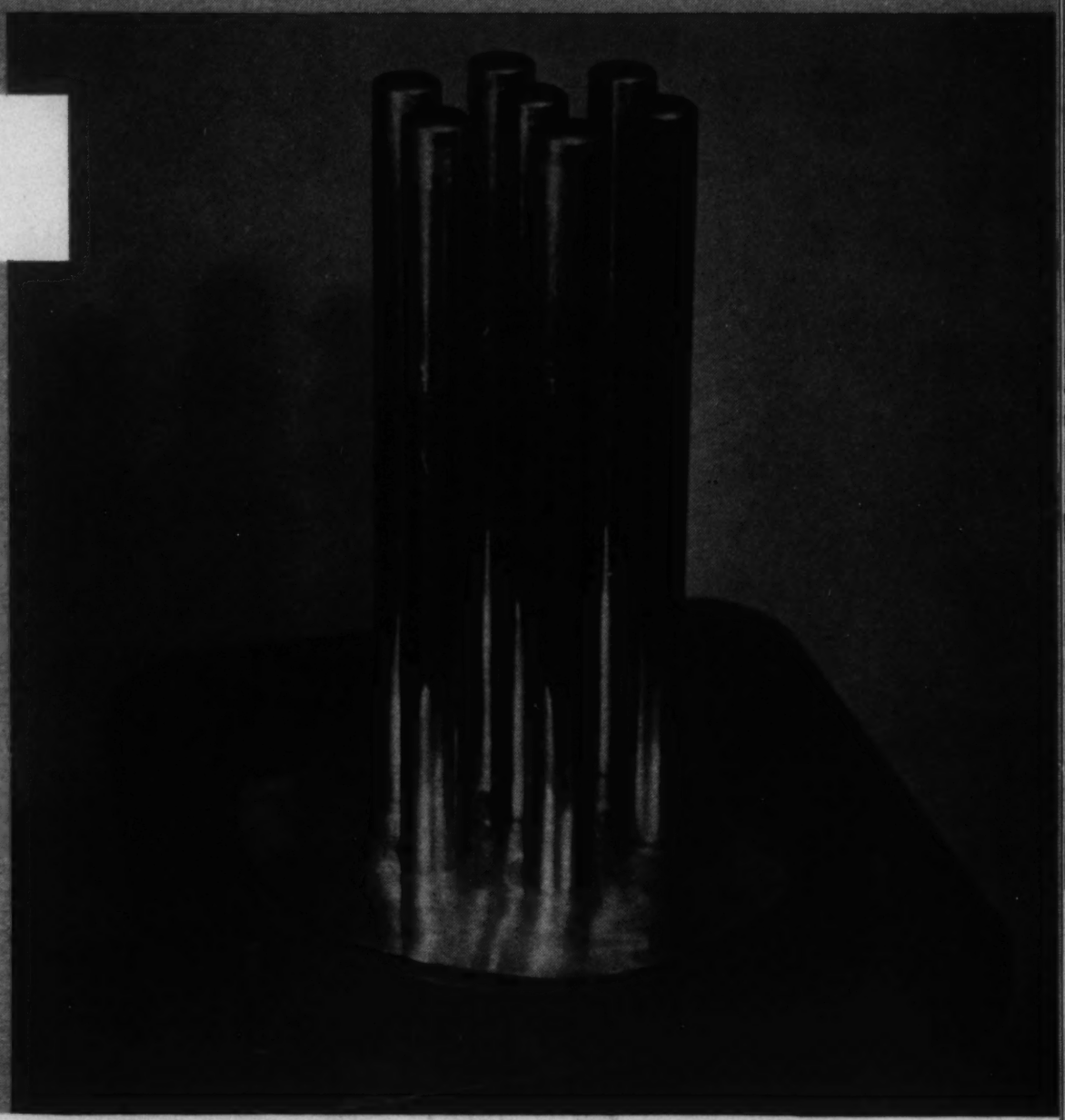


This candle-type heater uses platinum cladding to protect the base metals used in its construction.

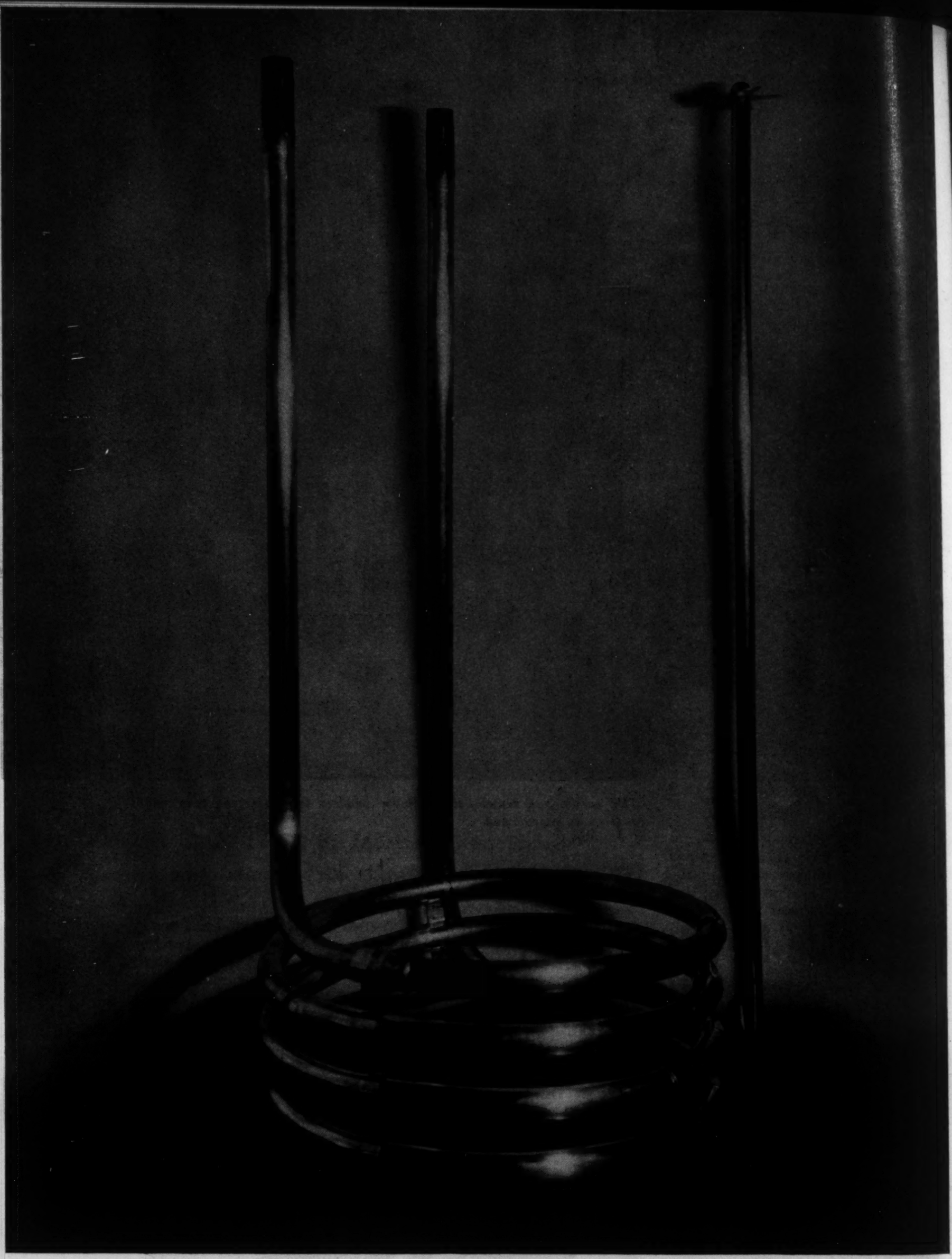
The Noble Metals Find Increasingly Wide Use in Industry

Pure noble metals and their alloys offer properties which are not found in other materials and which meet requirements of difficult jobs.

by **F. E. CARTER**, Baker & Co., Inc.

INDUSTRY IS BECOMING more and more exacting in its demands for metals and alloys that can withstand extreme conditions of temperature, pressure and corrosive agents; the engineer has challenged metallurgists by his insistence on new alloys for his jet engine and other aircraft developments, and the chemist has been no less demanding for new materials to cope with his many new corrosive compounds. The metallurgist has been responding with many excellent base metal materials, but none of these can be counted perfectly satisfactory; one may resist corrosion but will not stand heating without oxidizing or melting; another may be satisfactory in its ability to withstand high temperature, but may be so attacked by corrosive agents that it is unusable; or another may break down at high pressures.

The properties of the noble metals satisfy many of the requirements, and industry is making rapid strides in introducing them as the preferred material to use in chemical equipment. Admittedly, they are expensive and the initial outlay is high when they are used



Gold is used as the cladding material for this heat exchanger and stirrer.

for large pieces of equipment, but this apparent obstacle is much reduced by the fact that the metals can be readily resold at a value only slightly below the market price of new metal.

The noble metals comprise the six metals of the platinum group: platinum, iridium, osmium, palladium, rhodium and ruthenium, together with gold and silver. Of these, silver has by far the largest use in the chemical industry as a constructional material and would require a separate paper to do it justice; from space considerations it must, however, be omitted from the present discussion. Of the others, the three most used metals are platinum, palladium and gold, although the remaining four metals are highly important as alloying elements, where it is desired to have greater strength, hardness, or resistance to corrosion.

It is necessary at this point to make some remarks on the comparative properties of these noble metals and some of their alloys, so that intelligent selection for any particular application may be made. Only a few properties judged to be of interest to the designer of chemical equipment can be mentioned, and even in these cases the mention must be brief.

Melting Points—The high melting points of the noble metals constitute one of their advantageous properties; they are gold, 1063 C; palladium, 1554 C; platinum, 1773 C; rhodium, 1966 C; ruthenium, 2450 C; iridium, 2454 C; and osmium, 2700 C.

Workability—Gold is extremely ductile and is cold-worked from the original ingot to the finest wire and foil. Platinum and palladium are also highly ductile; for practical reasons they are usually hot-worked from the ingot to intermediate sizes and thereafter cold-worked. Rhodium is much less ductile; it is hot-worked to rather small dimensions and then finished cold; wire below 0.001-in. dia. and foil below 0.001-in. thick are obtained without much difficulty. Iridium has still less ductility; hot working is required, but subsequent cold-work, with high temperature annealing between draughts, is possible; in this way foil down to 0.001 in. has been made, but wire preparation is a more difficult undertaking, although diameters down to about 0.030 in. are available. Ruthenium is almost unworkable, although rather crude sheet can be made by sintering the powder and hot rolling. Osmium cannot be worked.

Hardness—As might be expected, the hardnesses of the seven metals run in the reverse direction to the ductility. In the annealed state, the Brinell hardnesses are about as follows: gold 30, platinum 40, palladium 45, rhodium 135, iridium 175, ruthenium 220, and osmium 350.

Heat Conductivity—Gold is an excellent heat conductor; the platinum metals are good conductors, but all the conductivities are considerably below that of silver. Taking the conductivity of silver as 100, they are: gold 71, rhodium 21, osmium 18 (appr.), platinum 17, palladium 16, iridium 14, and ruthenium 12 (appr.).

Electrical Conductivity—The conductivities, again taking silver as 100, are (approximately): gold 67, rhodium 36, iridium 33, osmium 18, platinum 17, palladium 16, and ruthenium 12.

Corrosion Resistance—All the metals are practically unattacked by any single acid, with the exception of palladium by nitric acid; even aqua regia has little effect on them, except in the case of platinum, palladium and gold. Discussion here of their resistance to corrosion by various agents would lead too far afield, and the reader is referred to the chapters on the noble metals in the "Corrosion Handbook" recently published under the aegis of the Electrochemical Society, where attack by acids, rate of oxidation and many related subjects are well summarized.

Alloys Offer Better Properties

As is rather general in metallurgy, alloys are frequently more useful than the metals themselves, and noble metal alloys conform to this generalization. For example, platinum is fairly soft, but small additions of other platinum metals and of gold rapidly increase the strength and hardness; thus, the Brinell hardness of annealed platinum, by the alloying of 10% of the other metals, is increased from 50 to 75 with palladium, 85 with rhodium, 125 with iridium, 150 with gold, 175 with osmium, and 200 with ruthenium. Naturally the ductilities vary to about the same extent, but inversely. Electrical and heat conductivities also are proportionately decreased from those of the pure metals.

As has been mentioned, the size of vessels made wholly of noble metals for the chemical industry is limited by the expense; a solution is the use of larger equipment of a base metal or a refractory with an inner lining of the noble metal. This lining may be a separate layer tightly inserted in place, or the whole vessel may be built of composite metal. Such composite metal is made by welding or soldering appropriate thicknesses of blocks of noble metal and base metal in a furnace and then rolling the duplex block to the desired thickness of sheet. "Composite" rods and wires are similarly made by slipping a noble metal tube over a base metal rod, welding or soldering, and rolling or drawing to the desired size. Composite piping with the noble metal either on the inside or outside, or both, of the base metal is frequently used in heat exchangers and similar equipment. The layer of noble metal in a composite can be quite thin, perhaps as little as 0.003 in., and still be completely immune to corrosive agents at normal temperatures. When the process is one entailing high temperatures, say up to 700 to 800 C (1292 to 1492 F), the noble metal should be considerably thicker.

Many important chemical processes are in operation that use such "clad" vessels with temperatures of a bright red heat. It should be mentioned, however, that when two metals are in contact at elevated temperatures a certain amount of interdiffusion is bound to take place; in time, therefore, the base metal will reach the inner surface and chemical attack will take place. Although this diffusion proceeds continuously at a measurable speed at elevated temperatures, the rate is slow and, provided a reasonable thickness of noble metal is used, the appearance of the base metal at the surface of the noble metal is long delayed.

In the construction of large vessels of composite metal or with linings of composite metal, there is always present the difficulty of welding or otherwise

joining together the constructional parts in such a way that no base metal is exposed at the inner surface. Certain designs of joints have been developed that are satisfactory, but extreme care is necessary if nothing but the noble metal is present at the exposed surface. It can be stated that platinum on nickel is a preferred material for constructing vessels or liners where such joints have to be made; with this combination fine gold can be used as a solder since it melts well below the melting points of platinum or nickel.

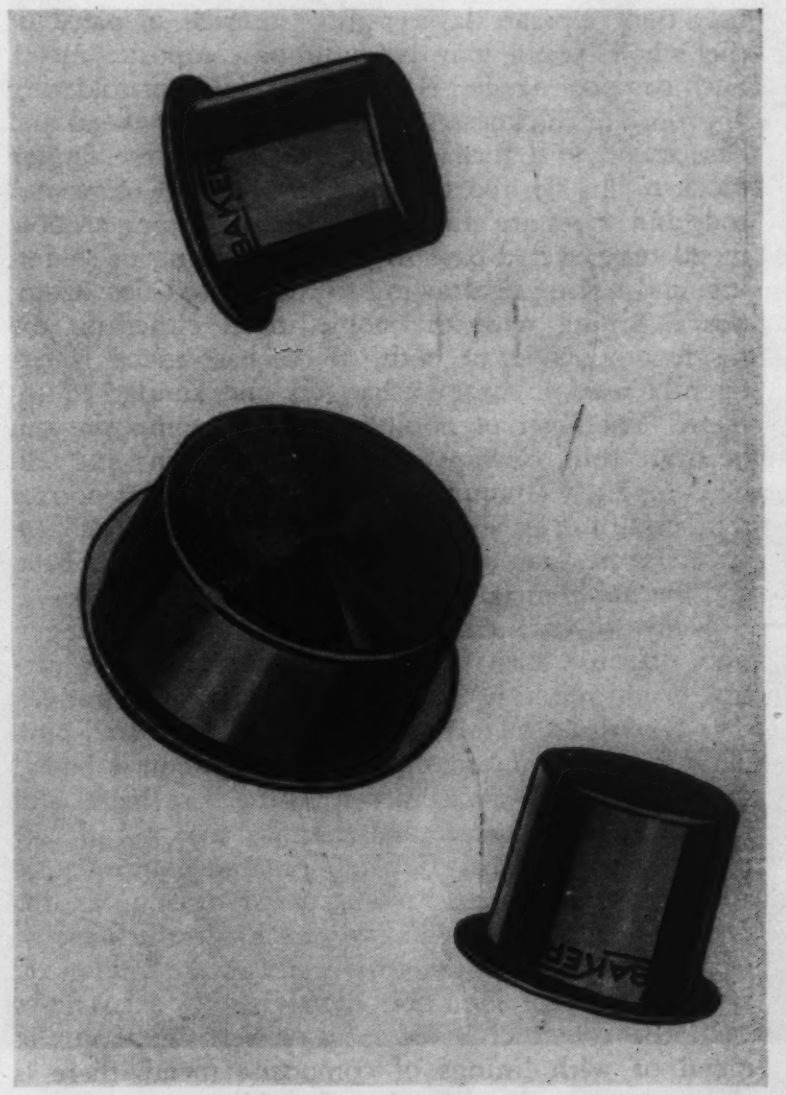
When the inner liner is a separate shell and consists of noble metal only, it is easy to line large vessels, because the separate sections of the liner can be readily dap-welded together at a red heat and no solder is necessary. If a solder is desired, fine gold is a completely satisfactory material.

Examples of Uses

A few examples of the use of the noble metals as a construction material may now be given:

The glass industry has recognized the value of platinum in protecting the refractory walls of glass furnaces from the severe corrosive action of molten glass. Even the best of refractories are perceptibly eroded by molten glass, especially when the latter is in motion; to prevent erosion, parts of the furnaces, particularly channels, pouring spouts, etc., are lined with platinum. Palladium has given excellent results as a liner for dies in the manufacture of bottle glass; thousands of tons of this low fusing glass have been fed from such lined dies without visible deterioration of the liner. One particular application of noble metals in the glass industry is in the manufacture of electric light bulbs; here a certain definite amount of molten glass is required to seal the bulb into its base. Formerly, the glass had been delivered through a refractory die which, however, enlarged so much by erosion of the flowing glass that soon an excess of glass in a unit of time was delivered, and in consequence the machine had to be stopped while a new die was inserted. A lining of platinum increased the life of the die a hundred fold.

The fact that minute holes can be accurately drilled in noble metals makes these metals valuable for synthetic fiber spinnerets.



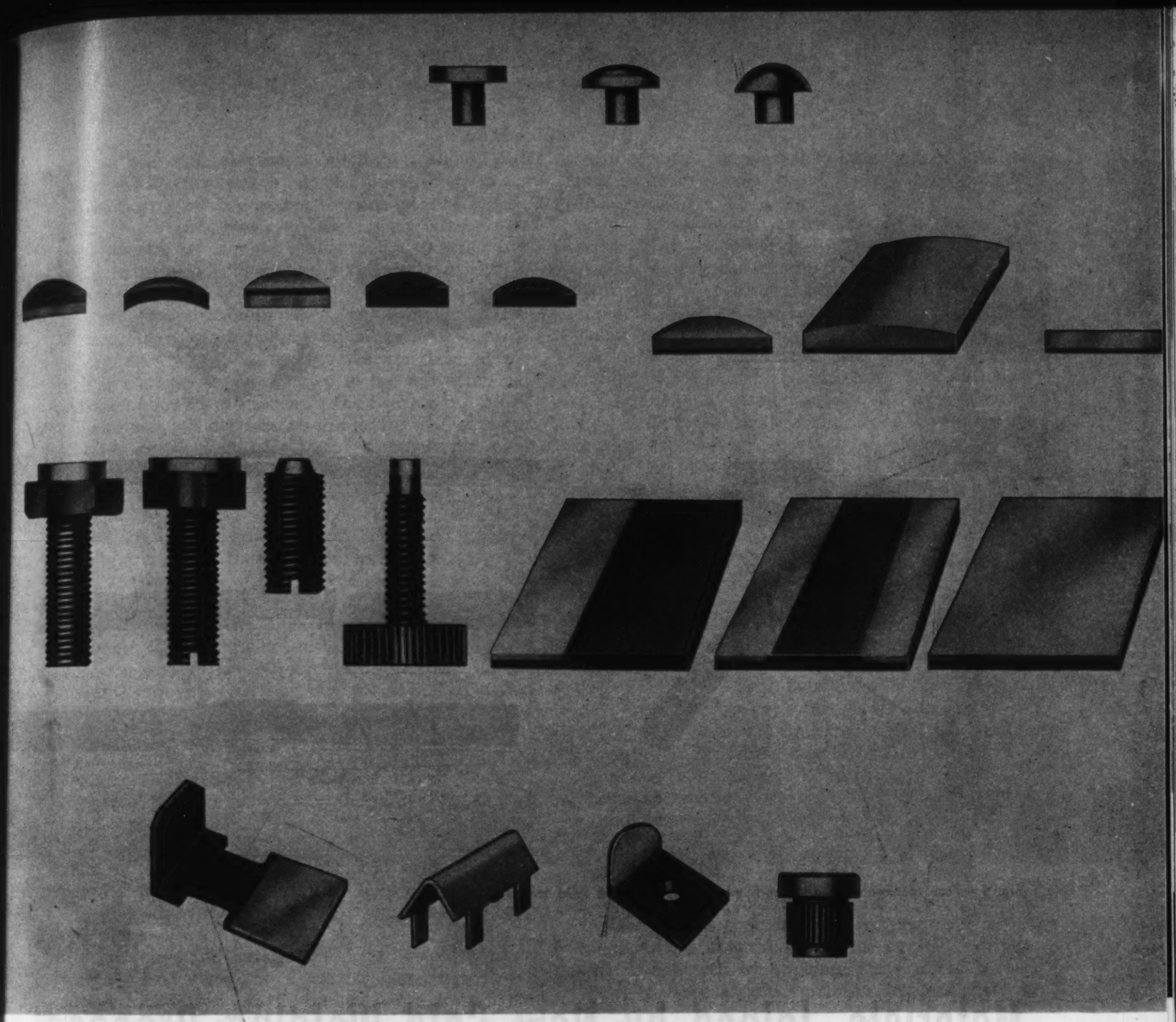
The great industry of synthetic fibers depends on the noble metals for its spinnerets. No other material than noble metal alloys seems to have all the properties desired by this industry. Alloys of platinum-rhodium, gold-platinum, gold-palladium, etc., can be so fabricated that the numerous minute holes of the spinneret can be made extremely accurate, both as to size and shape. The holes retain their size for a long time and are easily cleaned out whenever there is any tendency to stoppage by the viscous mass.

Important amounts of the platinum metals are used in the electrochemical industry for insoluble anodes. Sheets or rods of platinum or iridioplatinum are frequently used; for very large installations it is usual to encase a base metal anode in a sheath of noble metal. The union between the base and the cladding is so complete that the resistance to even heavy currents is only insignificantly increased. The preferable form of clad anode is a U-shape rod, since there is no danger of the base metal being exposed; straight rods or sheets are also used, but special precautions are necessary to seal completely the ends or edges. The two important advantages of noble metal anodes are long life and purity of product.

Increasing use of rupture disks is being made in the chemical industry to act as a simple form of safety valve; and when corrosive materials are being processed, it is necessary that these disks be made of noble metals. By proper selection of diameter and thickness and by close control of fabrication methods the disks can be made to "blow" at any desired point between a few pounds and thousands of pounds of pressure.

The noble metals find a large use in the field of electrical contacts. Since they do not form a superficial layer of insulating oxide, they are particularly valuable for contacts which "make" with very light pressures. Iridioplatinum is used in aviation magnetos and other instruments, palladium and its alloys in telephone circuits, and indeed, wherever absolute dependability is required noble metal contacts are preferred.

Recently, there has been a sort of reversion to the original method of handling platinum, namely to the powder metallurgy process. By this process and by suitable addition agents, platinum and some of its alloys have been prepared with properties superior to those of the cast alloys; they are considerably stiffer



Noble metals serve as at least part of each of these electrical contacts.

and retain their strength at elevated temperatures much better than do cast materials. These qualities have caused them to be introduced as electrodes in aviation spark plugs, as laboratory ware, etc., and no doubt other applications will arise in the near future.

Palladium is finding increasing uses in industry in addition to the more generally known applications in the dental and electrical contact fields. One example, in addition to that already mentioned in the bottle glass industry, is its use as trays for ignition of the various special powders used in treating the glass tubes for fluorescent lighting. Another is the very considerable development of gas purification, where a palladium catalyst is used to remove the last traces of oxygen from hydrogen; for many present-day processes absolutely pure hydrogen is required, and many large installations have already been made for purifying by this method. An alternative method of getting pure hydrogen is to make use of the unique diffusing property of palladium, which permits hydrogen, and hydrogen alone, to pass through.

These few examples of the use of the noble metals in industry are merely typical and could be multiplied many times, but in this place nothing more than a mere mention of several other uses can be included. There come to mind all the forms of laboratory ware, crucibles, dishes, electrodes, etc. for which platinum is essential; noble metal thermocouples; platinum for resistance thermometers; the numerous alloys with highly specialized properties for the dental field; fuse wires of iridioplatinum for detonating caps in the explosive field; and many others. Noble metal catalysts in the synthetic nitric and sulfuric acid fields take very large quantities of these metals, and in the field of synthetic organic chemistry platinum and palladium are widely used. Even this enumeration does not cover by far the various uses to which the noble metals are put in industry and, so broad and so important are their applications, it is difficult to imagine what we could do without them; indeed, it is interesting to speculate on the highly important station they occupy in our modern civilization.

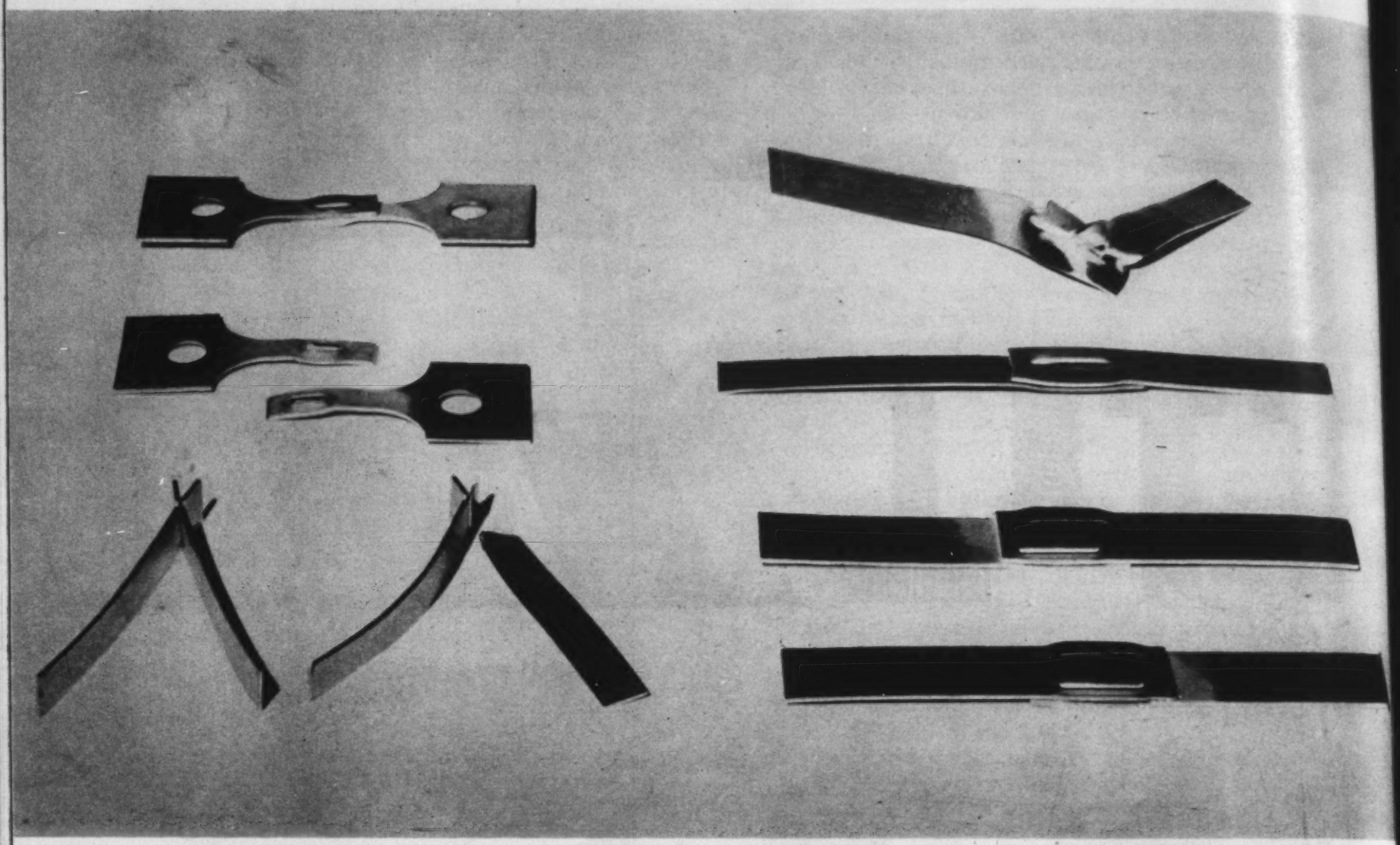


Fig. 1—Test specimens of aluminum welds made by the cold welding process.

Materials Joined by New Cold Welding Process

by A. B. SOWTER, Research Laboratories, The General Electric Co., Ltd., England

Strong welds in a number of nonferrous materials, particularly aluminum and copper, are possible with this simple cold welding method.

A METHOD ENABLING METALS to be welded at room temperature, called cold pressure welding, has recently been developed at the Research Laboratories of the General Electric Co., Ltd., in England. The process is at present most suited to aluminum and its alloys and copper, although other metals can be cold welded. No heat need be applied in order to bring about a weld. Ductile metals are made to flow at room temperature by the application of sufficient pressure. By using a suitable arrangement of work pieces and dies, this pressure also brings the work surfaces into contact so that a genuine weld is made.

As stated, the most satisfactory applications of cold

welding are with aluminum, aluminum alloys, and copper. Other nonferrous metals are not likely to be welded by this method except in cases where strength is not important. However, some materials of different hardnesses can be joined. Thus, copper and nickel have been cold welded successfully to aluminum.

In welding aluminum alloys, not more than 3% of manganese or silicon can be tolerated if a satisfactory weld is to be made. Heat-treatable alloys, such as Duralumin, can be used in the soft condition and then allowed to harden in the usual way. Work hardening has the effect of improving the strength of the welded metal. Half-hard commercially pure aluminum, for example, reaches an ultimate tensile strength of 22,000 psi., or about twice its original strength.

The strength of any joint made by cold welding depends upon its shape. The least satisfactory design is a single straight joint where the stress is perpendicular to the length of the weld. Here the material is weakest immediately around the weld area, *i.e.* where the final thickness shared by the two pieces is about ¼ of the original total thickness. Since, however, the material has now work-hardened and is twice as strong as it was originally, the welded piece is now half as strong as the original single piece. By a carefully designed layout of welds in relation to stress, it is generally possible to arrange the joint without sacrificing any tensile strength. The top left hand corner of Fig. 1, shows a tensile test specimen made up in 20 s.w.g. half-hard commercially pure aluminum where the weld is placed with its length parallel to the strip. Tensile failure occurred at 110-lb. load, by the pulling out of the weld area from one piece.

Strip joints and wire joints made by cold pressure welding have been tested for conductivity. A well proportioned joint in aluminum has a lower electrical resistance than an equivalent section of the unjointed material.

Surface Preparation

There are two important factors in the formation of a satisfactory weld. One of these is preparation of the surface, and the other is proper design of tools.

It is essential that the two surfaces, brought into contact between the dies, are entirely uncontaminated. Where aluminum is the metal to be welded, the oxide film covering the surface must be removed. It has been found that though this film is thin by ordinary standards, its presence is quite sufficient to prevent welding. The problem of how to clean it away by a treatment that does not leave behind any of the debris arising from its removal formed a substantial part of the development work.

Chemical cleaning methods are unsuitable since they inevitably necessitate a washing of the surface in order to remove solvents. Reaction with the washing water would then immediately reform the protective layer, whose removal was being attempted. Cleaning methods such as filing and treatment with abrasives have proved unsuccessful, the first because some of the material which is removed is invariably re-embedded in the surface by later working, and the latter because, in addition, it leaves behind particles of the abrasive.

The method which is now adopted is to treat the surface with a power-driven rotary scratch-brush. A steel wire brush, running at a surface speed of about 3000 ft. per min., has been most commonly employed. The surface of the work must be held against the scratch-brush long enough to make the drag felt; this occurs when the steel wires break through the oxide film and seize onto the metal surface beneath. Small particles of the body metal and its coating of oxide are torn out and flung clear because of the high speed at which the wires are travelling. The hardness and gage of the steel wire must be related to the dimensions of the work being treated, since it is obviously undesirable to weaken the structure by the removal of more metal than is absolutely essential for cleaning.

The surface of aluminum oxidizes immediately on exposure to the atmosphere, but some days elapse before the film reaches its final thickness. Once this relatively thick coating is removed and the metal is exposed, advantage must be taken of the time required for it to reform by welding immediately after cleaning. Satisfactory welds can be made several hours after the scratch-brushing process has been applied, provided that the cleaned surface has not meanwhile been contaminated by moisture or grease. Even the contamination conveyed by handling will invariably prevent a weld from forming.

Design of Tools

For successful cold welding the pressure must be applied over a comparatively narrow strip, so that the metal can flow away from the weld at both sides. This is achieved by applying the pressure between specially designed dies, and this imposes slight re-

Fig. 2—Undesirable curvature results from a radial flow of metal such as results from circular dies.

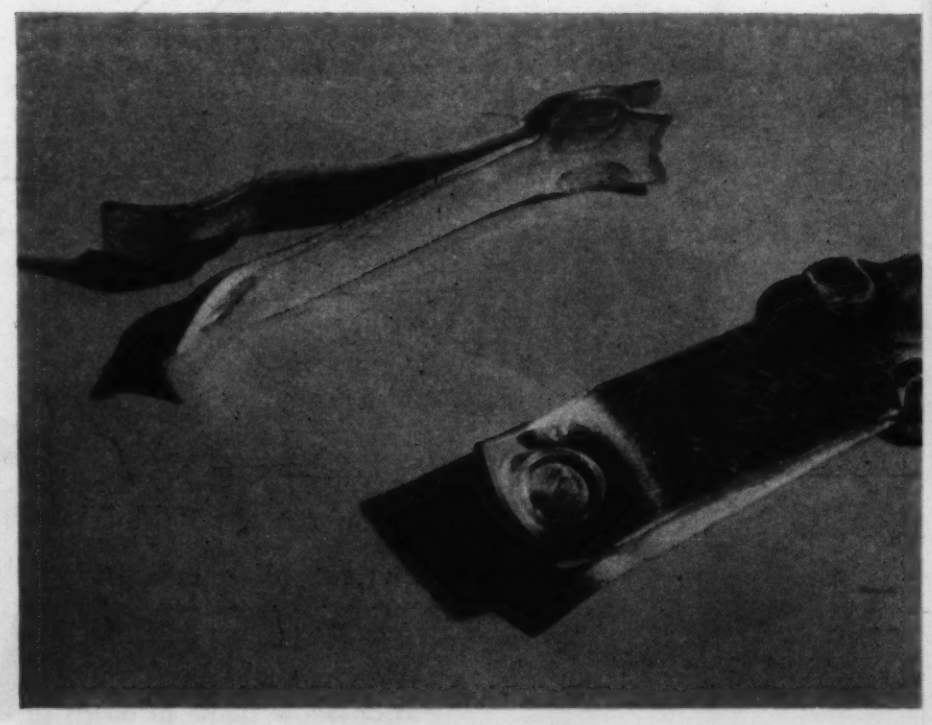


Figure of Merit of Materials That Can Be Cold Welded

Material	Figure of Merit
Super-Pure Aluminum	40
Commercially Pure Aluminum	about 30
DTD 346 (51S)	29
BA 60A (3S) (1¼% Mn)	20
Duralumin	20
Cadmium	16
Lead	16
Copper	14
Nickel	11
Zinc	8
Silver	6

strictions on the more complicated forms which these welds can take. The undesirable curvature resulting from a radial flow of metal can be seen in Fig. 2, which shows the results obtained with circular dies. When these welds were first attempted in the center of the strips, radial flow occurred and no welding tok place. Identical circular indentations were then applied to the side of the strips and satisfactory welds resulted owing to the uni-directional flow produced. Ring welds and other closed forms can, however, be made successfully, provided that there is sufficient free area within the weld to accommodate the excess of metal without undue buckling.

The material used for making dies for commercially pure aluminum is usually mild steel, while on unhardened chromium-manganese tool steel is also satisfactory. These materials give no trouble with pick-up of aluminum, a slight surface contamination, resembling a thin plating, being the only evidence of pick-up occurring. It is possible that pick-up may be troublesome if an unsuitable steel is used for welding rollers. A detailed list of such unsuitable materials cannot yet be given, but the present practice is to avoid tungsten and molybdenum steels. Where suitable die materials have been used, there is very little evidence of die-wear. In many applications, however, it will be possible to counteract the effects of such wear by an occasional resetting of the die closure.

The pressures required for cold welding are only slightly above the flow of aluminum, in the region of 24,000 to 36,000 psi. That required for copper is from two to four times this value. The rate of application of the pressure does not appear to affect the strength of the final weld. Good welds can be made with tools giving either a slow squeeze or an impact.

As already seen, the shape of the tool is important. Where a rectangular form is used, the size of the rectangle depends on the gage of the sheet being worked. Where symmetrical tools, working from both sides of the weld, are used, W, the length of the rectangle, is made equal to the gage thickness, t; L, the length of the rectangle, must not be less than 5t. Where it is desirable to keep one face free of indentation, a single tool is used in conjunction with a flat plate or anvil. In this case, W is increased to ½t.

When cold welding materials of different hardness, in order to share the final thickness equally between the two materials, the width of the welding tool must be adjusted according to the hardness ratio. Thus, W for a tool in contact with aluminum against copper is increased to 2t, since the hardness ratio of copper to aluminum is approximately 2:1 in the annealed condition.

The final gap between the tools, or between the tool and the anvil, may either be set by a stop which limits the closure of the press or by a shoulder on the tool. It is more advantageous to use the shouldered tool, since it restores the distortion produced by the actual welding process. Both plain and shouldered tools can be used for impact welding. The former, with a closely controlled blow such as that given by an automatic centre punch, is used for welding gage thicknesses of the order of 0.012 in. The latter, using a specially shaped punch and a hammer, can be employed for thickness of the order of 0.036 in.

The gap between the tools, or the tool and the

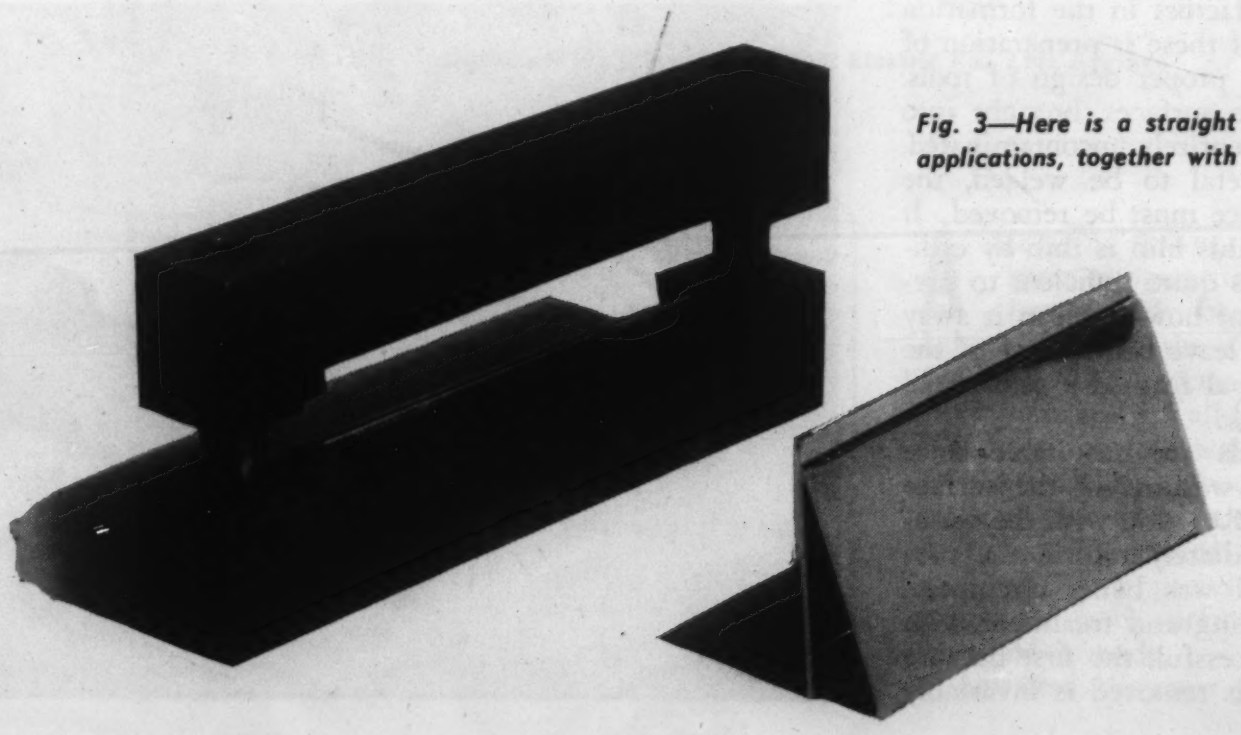


Fig. 3—Here is a straight weld which is used in commercial applications, together with the dies used.

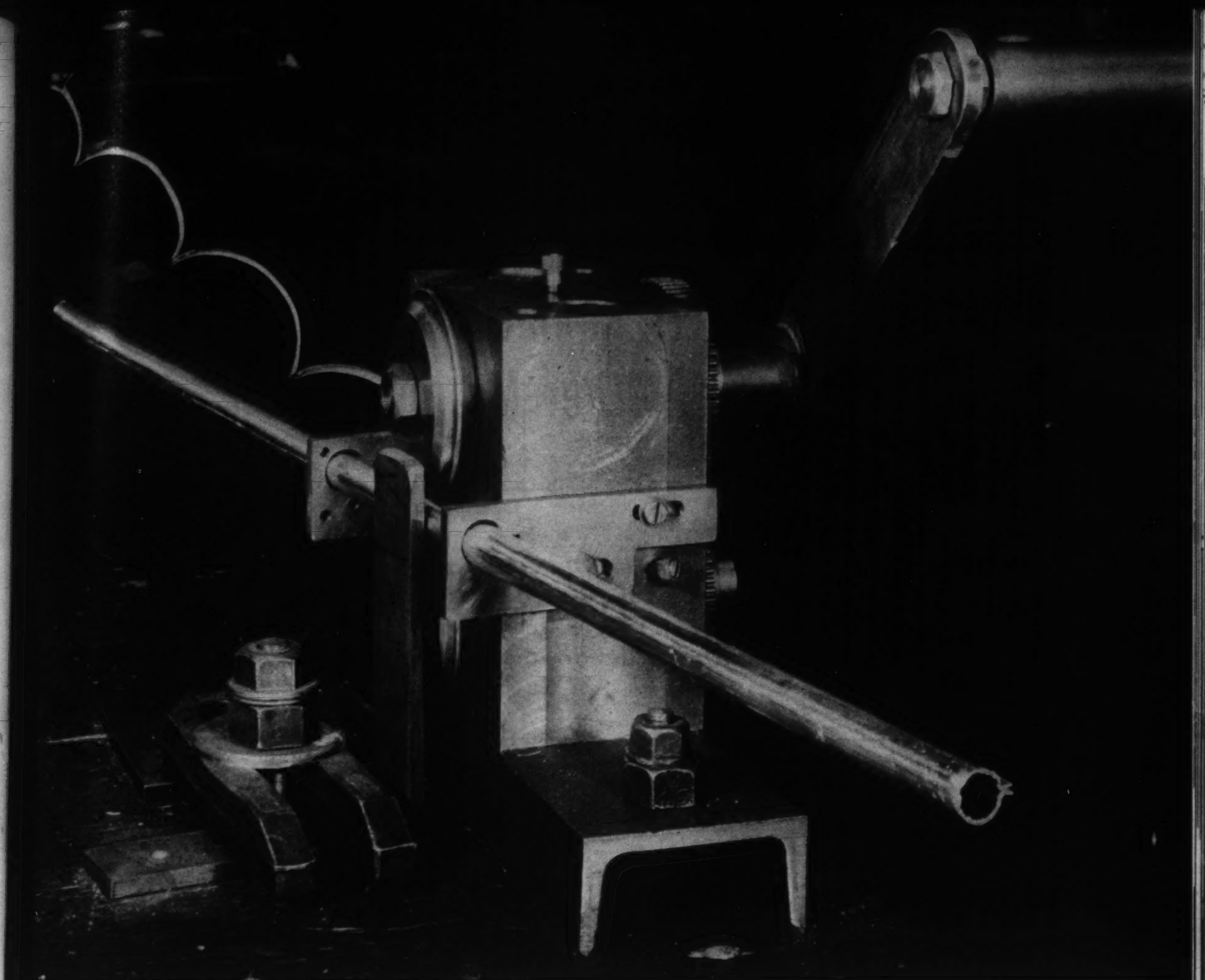


Fig. 4—Cold welded pipe is trimmed to remove the metal flange formed by metal flow.

anvil, is limited in order to prevent further penetration after the welding point has been reached. The minimum reduction in thickness required to ensure a satisfactory weld varies from metal to metal. The "figure of merit" used to classify metals, as regards their suitability for the process, is given by the ratio:

$$\frac{\text{Thickness of Weld}}{\text{Twice thickness of original material (T)}} \times 100$$

The correct gap for the tool is therefore given by the "figure of merit," values of which are given in the accompanying table. For example, since the value for commercially pure aluminum is 30, the gap should be set at $\frac{30}{100} \times T$, where T is the double thickness.

Applications of the Process

This cold welding process has already been used with success in a number of different applications. An example of a straight weld is shown in Fig. 3. This can be used for box-seams, for sealing tube ends, and for other forms of capped joint which are almost equivalent to butt-welds. The ring weld already described can be used for joining a flanged tube to a plate for making hose connections, or two disks can be joined together to make an air pressure cell. The most important application of the continuous seam-weld is for tube-making. A machine has been constructed in the Research Laboratories of the General Electric Co., Ltd., in which the process of preforming, scratch-brushing, final forming, welding and trimming is carried out continuously and automatically. In addition, a roller welding machine can be used to seal the edges of a folded section following a complicated outline. The free edges of a box-shaped section may also be seamed by rolling in such a machine.

Much interest in this process of cold welding has already been shown. Its many applications are obvious, and it offers a promising new joining method to those engaged on large-scale production, as well as to those in small workshops.

Metal Powder Parts Replace Those Produced by Other Methods

Presented here are six case histories showing how metal powder parts can replace conventional metal forms by cutting costs and improving design and product quality.

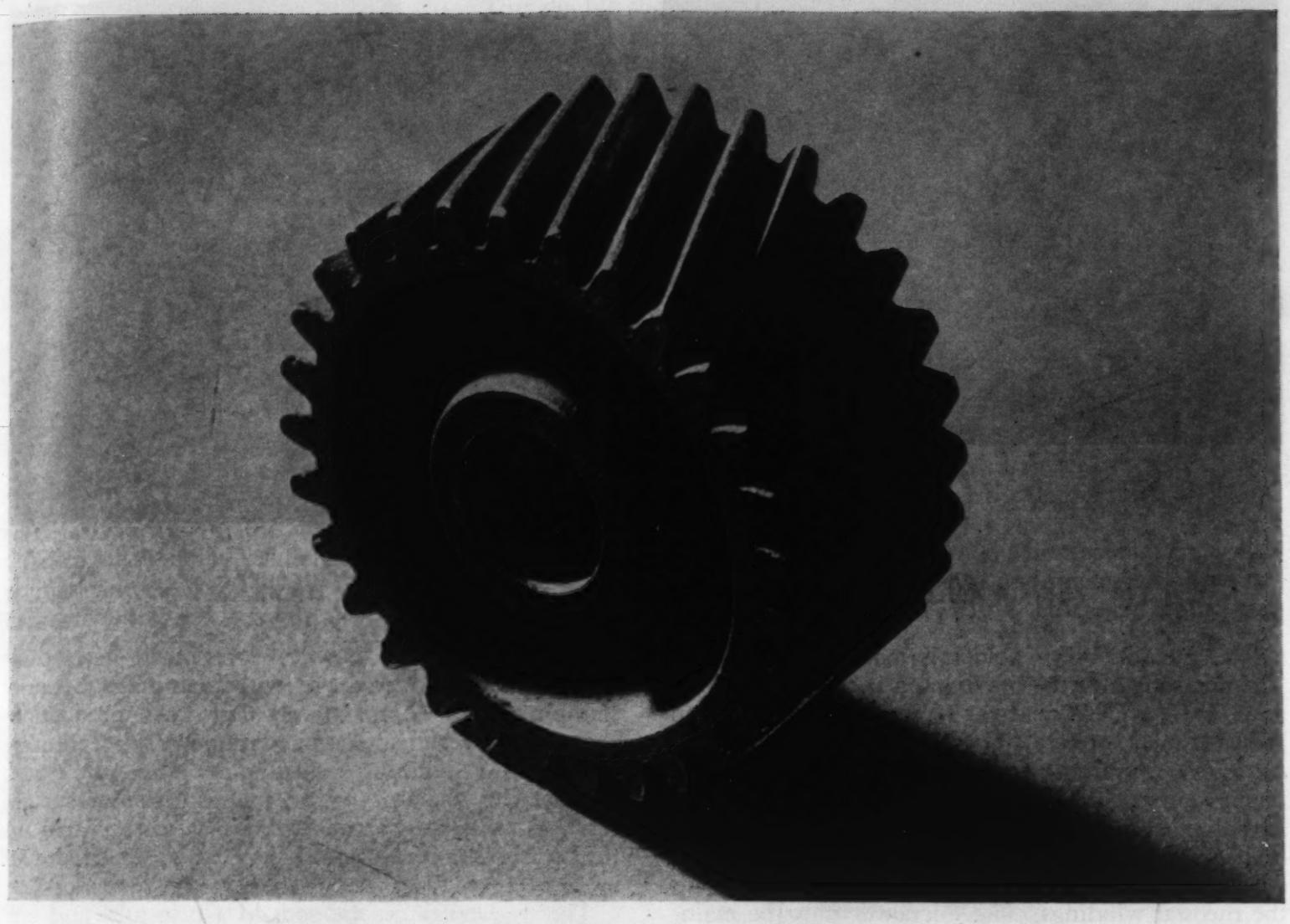
by **H. R. CLAUSER**, Associate Editor, Materials & Methods

ALTHOUGH METAL POWDER PARTS have been available to industry on a reasonably large scale for around ten years now, there is still a great deal of uncertainty as to just what types of applications they are best suited for. Six case histories are assembled here to illustrate a few of the many and varied uses to which the products of powder metallurgy can be put.

The uses of metal powder parts fall into two main groups. The first are those applications in which the part is impossible to make by any other method. For example, parts made of refractory metals like tungsten and molybdenum cannot be made efficiently by any other means. Porous bearings and many types of magnetic cores for electrical and communications equipment are exclusively products of powder metallurgy. The second group of uses consist of those which compete with other types of metal parts, such as machined parts, stampings, castings and forgings.

All of the case histories that follow fall into the latter group, for it is here that the full potentialities of powder metallurgy have not as yet been realized. Its relatively slow progress in this field of applications has been due to a number of reasons which cannot be gone into here. But one of the important reasons is the general lack of knowledge about both its capabilities and limitations. In one particular case, for example, the engineer at first discounted the use of a metal powder part for his product because he assumed that the particular part could not be mass produced as rapidly by powder metallurgy as by a multiple cavity die casting operation. Further investigation showed that the part could be made actually faster by powder metallurgy, and consequently the metal powder part was adopted.

Because powder metallurgy is still a relatively new process, before a metal powder part is selected it must not only be able to meet the regular service requirements, but must also show a definite advantage over conventional methods of production. It will be seen from the case histories that the decision of whether to use a metal part generally depends upon several questions. One, and perhaps the most important, is does it result in a savings in cost of the part? Two, are there any design advantages gained—that is, can the part be made simpler or in less pieces than formerly? And three, is the quality or service performance of the part improved? In each of the following case histories the answer to one or more of these questions was favorable and resulted in the adoption of a metal powder part for the application.



HELICAL GEARS

Helical gears at first glance appear to be a type of part impossible to make by powder metallurgy methods. However, they are now being produced successfully by Merriman Bros., Inc., for the A. C. Gilbert Co., who are using them in their food mixers, toy electric trains and motors. We will confine our discussion here to the helical drive gear used in the household food mixer.

This helical gear has a 1½-in. outside dia., 0.37-in. bore dia., is ⅝ in. thick and has 29 teeth. The helix angle, which is the main design feature, is about 22 deg. The required tolerances are 0.003 in. max. in the overall pitch dia. and 0.001 max. in the bore dia. The gear is press fitted onto the shaft.

The former method of making this helical gear was by conventional gear cutting methods. The material used was SAE 1040 steel. The operations were as follows: (1) Blank is drilled, reamed, and cut-off to size, using a screw machine. (2) Teeth are hobbed, three blanks at a time. (3) Burrs are removed from every third gear. (4) Gear is assembled on shaft, then induction hardened.

The part now being made by powder metallurgy involves the following steps: (1) Powder is pressed in specially designed dies to permit withdrawing from the part. (2) Part is sintered. (3) Part is case hardened by carburizing. A salt bath was first tried, but salt was absorbed into the pores of the compact and later bled. Gas carburizing was therefore tried and found to be successful. (4) After case hardening the gears are impregnated with oil. These particular gears are made of an iron base powder; however, helical gears of brass and copper have also been produced satisfactorily.

There are two principal advantages derived through the use of powder metallurgy for this part. First, the sintered metal part is lower in cost, its final cost being approximately equal to the cost of producing just the gear blank by conventional methods. Second, the metal powder part is self lubricating. This assures adequate lubrication of the gear assembly in service and simplifies the lubrication problems encountered with the machined gear.

The important properties of the gears from the standpoint of performance are hardness and wear resistance. The metal powder gears are hardened to a grain hardness of about 62 Rockwell C, and this provides a wear resistance about equal to that of machined gears made of heat treated SAE 1040 steel. The finish tolerances, cited earlier, are easily maintained in the metal powder parts, and their surface finish is equal to that of conventional machined gears.

BRUSH HOLDER

The rheostat brush holder is made in three sizes. The one shown in the photograph is about 1 in. long and ⅜ in. square, with a 3/16-in. slot in the top for holding a graphite brush. There are a number of critical requirements that must be met in the manufacture of this brush holder. The graphite brush assembly is soldered between the two ears of the holder; therefore, the part must be receptive to soldering. To assure proper contact of this brush with the rheostat windings, close tolerances must be maintained. Between the ears, the over-all tolerance is on the order of 0.0005 in. and on the outside dimensions it is 0.001 in. The part must also have high conductivity and not discolor excessively with handling. Finally, the part must have sufficient tensile strength and ductility to prevent breakage.

The conventional method of producing the brush holder was by either machining from 85-15 brass bar stock or machining and finishing from extruded stock. Both methods required costly machining, deburring and finishing operations. To cut the cost of producing the part, development of a metal powder part was undertaken by the American Sintered Alloys, Inc. For an acceptable metal powder part, the requirements listed earlier had to be met, and this was done successfully.

A high density 85-15 brass powder, when accurately processed through the pressing and sintering operations, was found to have a conductivity at least 95% of that of brass bar stock. The solderability of the metal powder part also proved satisfactory, and the close tolerances previously mentioned were maintained. The finish obtained was bright, clean, smooth, and free of machining marks and burrs.

Thus, from the standpoint of performance the powder metallurgy part was equal to the part made by conventional methods. The deciding factor in its favor, therefore, were the savings realized in production cost. The die costs were normal, being about equal to a die casting die for the same job. Scrap loss was negligible, and the savings per part amounted to about 25%.

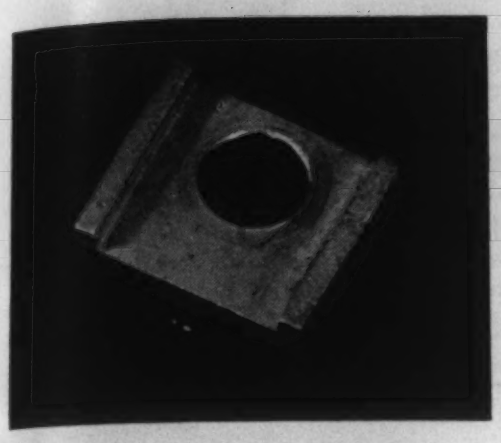
FUSE WASHERS

In general, metal powder parts have been considered unable to compete with stampings because stamping is a comparatively low cost production process. However, in recent years powder metallurgy has replaced stamping in a number of applications, particularly where it offers savings through design changes and improvements. A typical case is that of fuse washers for replaceable electric fuses produced by Sintered Metals, Inc., for the Chase-Shawmut Co.

The washers fit on the ends of a fuse tube and are designed for quick removal and assembly when replacing burn-out fuse elements. They range in size from 0.8 in. to 2⅜ in. in dia., and from 0.23 to 0.38 in. thick. As seen from the photograph, there is a stepped rectangular slot in the center of the fuse through which the contact blades of the fuse protrude. The successful operation of the fuse depends upon having proper clearance between the blades and washers to assure the release of gases when the fuse "blows." For this reason tolerances of ±0.0025 in. must be maintained on the slot dimensions.

The washer was formerly made up of two stampings and required a comparatively intricate design to assure proper clearance upon assembly in the fuse. By adopting powder metallurgy to produce the washers, it was possible to simplify design and make them in one piece instead of two. The critical slot tolerance was successfully met, as is proved by the fact that ¼ million of one particular size washer have been shipped without a reject from failure to meet the tolerance requirements. A further advantage of the metal powder fuse washer is that it simplifies assembly of the fuse and also makes it more easily replaced.

The washers were made originally of copper, but at present 80-20 brass is being used. The cost of this part is reported to be approximately equal to the cost of producing the part by stamping. However, since assembly of the washer in the fuse is simplified with the one-piece metal powder washer, over-all cost of the fuse is reduced.



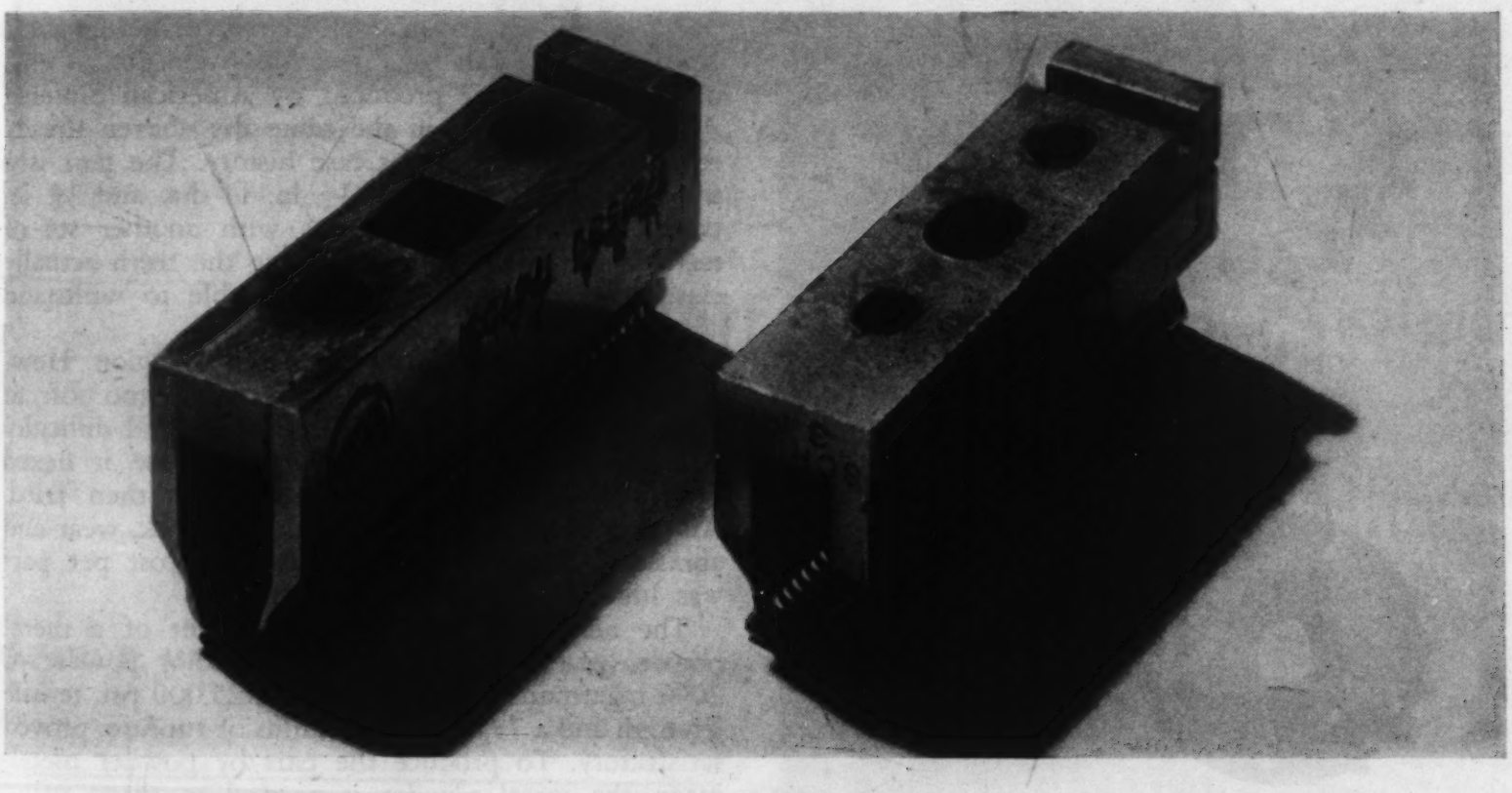
DOUBLE SLIDE BEARING

This double slide bearing, used in business machines, was specifically designed as a metal powder part after various other designs proved impractical. The part, made by Sintered Metals, Inc., is ½ by ⅝ by 5/16 in. thick, and has two bearing surfaces. The one bearing surface is a ¼-in. shaft hole and the other is a ½-in. slide-way. A 1/16-in. hole is drilled through one side of the part perpendicular to the shaft hole bearing surface. The tolerances on the bearing are quite critical. The over-all tolerance on the width of the slide-way and on the shaft hole diameter is 0.001 in.

In designing the part, a series of three steel stampings joined by spot welding were considered. This was a costly method of fabrication; in addition, when assembled into the main unit, the tolerances could not be maintained and improper alignment resulted. A machined part was also considered but was rejected because of the high cost.

Following this preliminary work, the double slide bearing was designed as a single piece to be made of 85-15 brass powder. The results were highly satisfactory. The specified tolerances were met and the problem of maintaining proper alignment in assembly was eliminated. The important service properties of this part are wear resistance and bearing properties, and these were found to be satisfactory in the metal powder part.

Since these double slide bearings made by other methods did not reach the production stage, no data on savings possible through use of a metal powder part are available. However, it can be said that one of the deciding factors in choosing the metal powder part was the evident savings in cost over the stamping and machining methods of production.



SHEARING HEAD BLOCK

The case of the outer shearing head block used in the Schick electric dry shaver and manufactured both by Presmet Corp. and American Sintered Alloys, Inc., well illustrates how producing a part by powder metallurgy often permits a number of cost saving design changes not only in the part itself but in other parts of the assembly. Reference to the accompanying photograph shows that the outer shearing head block consists of a block about 1¼ in. long having three holes and a narrow slot in the bottom. To the block is fastened a serrated shell.

The old shearing head block assembly made by machining methods consisted of two rectangular blocks which were cut out of SAE 1020 steel bar stock. The production operations involved drilling the holes, milling the notch and then machining to final dimensions. The shell used with the machined shearing block was a complex machined part and was joined to the block by soldering.

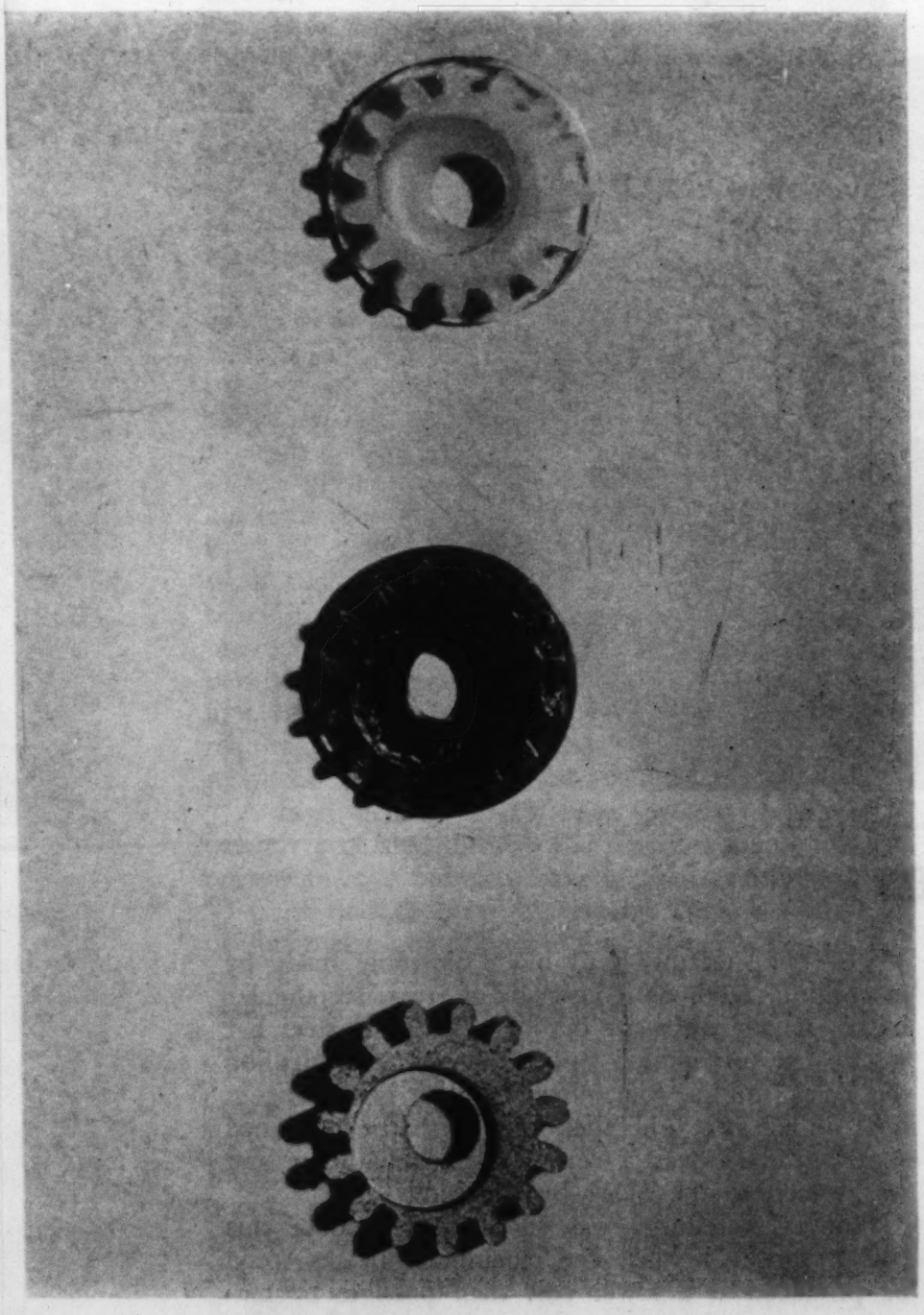
Powder metallurgy was adopted to produce this part primarily because the rectangular blocks could be produced at a lower cost than possible by ma-

chining. An iron-base powder having a composition of around 3 to 5% copper, 0.15 to 0.30% carbon and the balance iron was found satisfactory for the job. The powder metallurgy part was designed as one piece instead of two, and joined to the shearing head shell by four spot welds on each side. At first, steel dies were used for pressing the metal powder part, but when they proved unsatisfactory, carbide dies were adopted with success. Because of the relatively high production runs, the difference in cost between carbide dies and steel dies was insignificant.

After the initial success of the metal powder parts, several design changes were made which further cut production costs. Four projections were placed on both sides of the block. This permitted the use of a one-operation projection weld in place of the four spot welds on each side. In addition, the block was redesigned with "ears" to provide a more rigid support for the shearing head shell. This, in turn, permitted a redesign of the shell from a complex machined part to a simple stamping.

In considering powder metallurgy for this part it was also necessary to investigate its weldability as well as whether it could be chromium plated. It was found that the weldability was about the same as the machined part as long as the part was kept free of oil. In plating no difficulties were encountered, and a chromium plate essentially equal to that on bar stock was possible. However, absolute cleanliness is essential and electrolytic cleaning of the part before plating is required.

It is difficult to give the exact savings realized through the use of powder metallurgy for this part, because of the many design changes and factors involved. Also, the particular shearing head block discussed has just gone into production and no figures are available. However, based on an earlier and similar head, a conservative estimate of savings is between 30 and 40%.



STARTER GEARS

An interesting and unusual case involving a switch from a plastic part to a metal powder part is that of the starter gear produced by American Sintered Alloys, Inc. for use in the same dry shaver already referred to in a previous case history. The part is a small circular gear, about ½ in. in dia. and ⅛ in. thick. In operation it meshes with another set of teeth. Since in the initial meshing the teeth actually clash together, the gear must be able to withstand considerable abrasion and shock.

The first starter gears were made of nylon. However, it was found that this plastic was too soft to resist abrasion; it was also too flexible, and difficulty was encountered during assembly because it flexed out of shape. A phenolic plastic was then tried. Although it proved rigid enough, its shock, wear and abrasion resistance was low; also, the cost per part was higher than that of nylon.

The next step was the development of a metal powder gear. A heat treatable iron alloy powder of 20% maximum porosity, having a 25,000 psi. tensile strength and a 73,000 psi. modulus of rupture, proved satisfactory. To produce the part by powder metallurgy, the metal powder is pressed to shape using carbide dies and then sintered. Although this metal powder is heat treatable to greater physical properties, it is not required. The gear requires no coining operation and is used as sintered. The final operation is to impregnate the gear with oil.

It was found that powder metallurgy provided a gear equal in cost to the nylon part and cheaper than that made of the phenolic plastic. Also, the metal part was harder, had greater abrasion and shock resistance than the plastic parts, and did not distort during assembly. In addition, better tooth shape was obtained and the gear design was simplified by elimination of the shroud formerly required on the plastic gears to meet strength requirements.

Copper alloys are melted in oil-fired furnaces, four of which are seen in this illustration.

Close Control Required in Casting High-Conductivity Copper Alloys

by **PAUL G. MAGANUS,** General Manager, Warren Foundry Div., Progressive Welder Co.

Impurities, as well as improper heat treatment, cause electrical conductivity to drop; thus all foundry steps are carefully watched.

WHEN HEAVY ELECTRICAL CURRENTS must be carried with minimum loss, the choice of metals to serve as the conductor is quite narrow. Copper, silver, or aluminum will be considered as the first choices if conduction is to be made under ordinary conditions prevailing in industry. If the parts to act as the conductors are moderately large in size, and must be sold at competitive prices, silver will drop out of the picture because of price. When the piece must possess structural strength as a part of a machine in addition to the conductivity requirement, the choice is narrowed down to copper and certain of its alloys for all practical purposes. Aluminum possesses fair electrical conductivity, but in the strong alloys conductivity falls off rapidly.

This is the choice that has been made in designing the welding jaws for spot welders, especially for the portable welding guns. Clamping pressure must be exerted through the jaws, so that a high degree of strength is necessary. The electrical currents carried are high enough to demand excellent electrical conductivity as a prime requisite, to maintain the electrical efficiency of the machine.

Two compositions meet requirements for practically all of this work. They are:

1. Cast high-conductivity copper, used when some sacrifice of strength can be made in the interest of best possible conductivity.
2. Cast beryllium-nickel-copper alloy, used when best strength or least weight must be combined with the required high electrical conductivity.

Production of the pieces required in these copper-base compositions entails foundry techniques differing somewhat from those in the ordinary brass foundry, with controls carried to considerably greater degree. Electrical conductivity falls off sharply with increase of impurities in most conductive metals, and this is the case with copper also. For example, slight changes in the treatment of the melt will lower the electrical conductivity of the conductive copper from an equivalent of 90% to about 80%. This change is very important in a material designed for maximum conductivity.

Of the foundry practice in general, sand control is a daily routine. Green and dry sand molds are used, with skin-drying done by a torch. Skin-drying of the molds with infra-red heat is contemplated as an early step in an attempt to increase production without enlarging the actual working space. The actual mold surfaces are given a fine graphite cover to improve the surface of the metal. Melting is done in oil-fired pots, covered during melt-down, and only opened for the purpose of making additions to the charge, or for pouring into the ladles.

Control of the quality of the ingot materials is of utmost importance. No scrap metal whatever is used in making up the charges; copper is supplied as electrolytic copper, and the alloying elements as master alloys of high purity. Gates and risers normally compose not more than 50% of the melt so as to obtain metal of the dense quality required, and are carefully segregated according to composition, cleaned, and returned to the appropriate storage space.

A complicating factor in producing the copper and alloy castings for welding applications is that most of them must have cast-in tubes for cooling water. These tubes are of nickel, stainless steel, or plain carbon steel, depending upon conditions in the end use of the product. It is necessary, then, to pour the copper around the tube in the mold so as to (1) insure a good bond between tube and copper over all mutual areas, to obtain rapid heat transfer in the finished piece; and (2) to prevent collapse of the tube during the period when it is subjected to the heat of the molten copper, or while the metal cools and contracts.

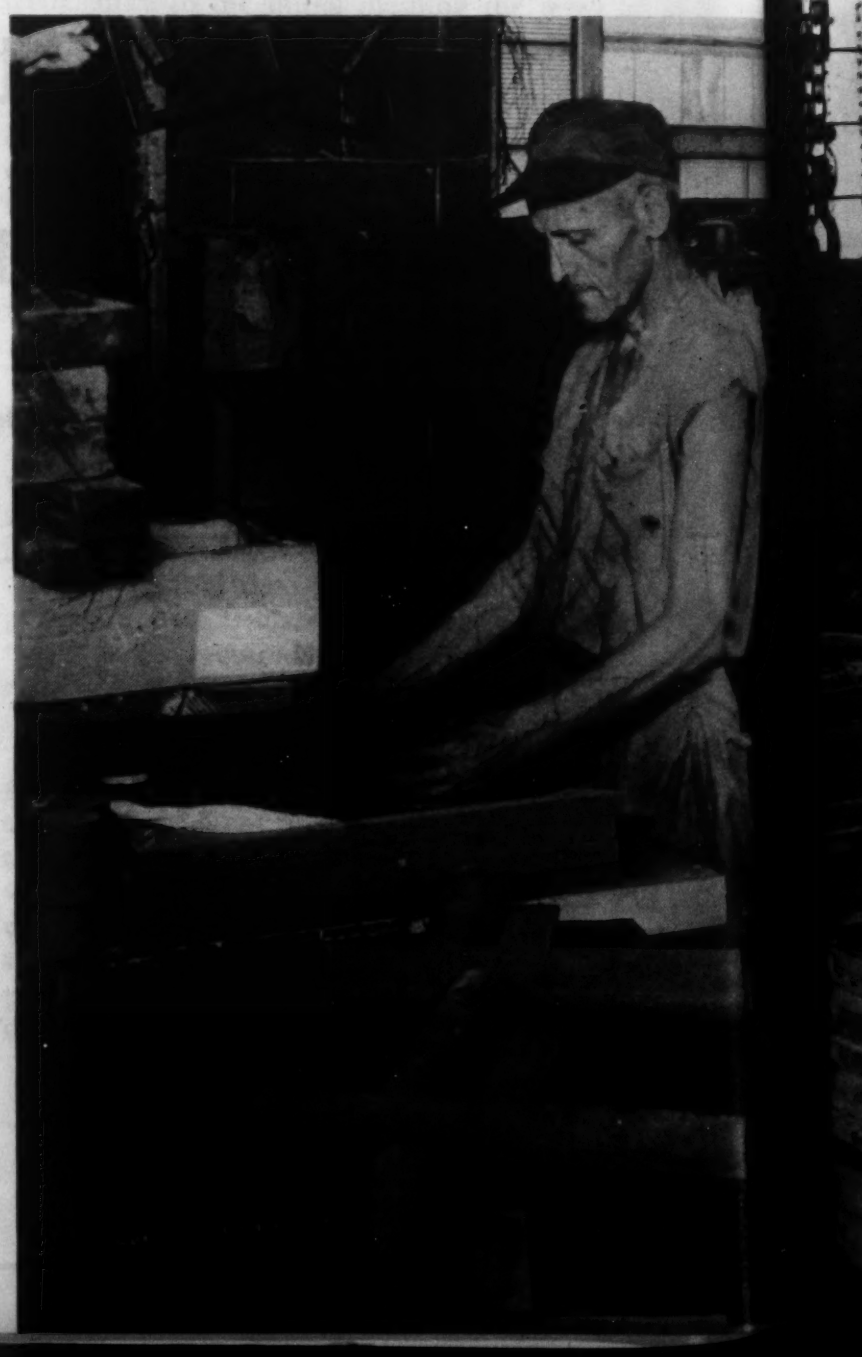
The problem of tube collapse has been met by welding shut both ends of the tube and filling with nitrogen gas at a pressure just above atmospheric before sealing. This not only prevents collapse of the tube, but stops any molten metal penetration of the tube through a defective seam, and reduces the danger of "blows" in the casting. Shot blasting of the external surfaces of the tube has been sufficient to effect a good bond during casting in most cases, but coating of the tube with copper, by either electroplating or metallizing, has been resorted to when necessary.

Beryllium-nickel-copper alloy castings have the following composition:

Beryllium	0.5%
Nickel	2.0%
Copper	Balance

In making up the charge for the furnaces, nickel shot is preheated with dry charcoal in the pots, and electrolytic copper is then added. The nickel shot is 93% nickel, and about 6% silicon. With the flame held at or near the neutral point, the material is melted down at 2250 F. The silicon acts as a deoxidizer, but to be sure of deoxidization before adding the beryllium the melt is deoxidized with lithium-copper, using a little more than 1% of the weight of the melt. The lithium-copper is about 2% lithium, and is added by introducing to the bottom of the pot, and stirring. The melt is then purged with dry nitrogen gas for about 3 min. A stainless steel tube with ⅛-in. holes along its side, and with the end sealed off, carries the nitrogen gas to the bottom of the pot and permits it to bubble through the melt.

A portion of Warren's core room. Cores in the foreground are for welding machine arms.



Beryllium is added as a 4% master alloy with copper. The ingots of the concentrate are preheated to about 1000 F before addition to the furnace; this cools the melt to about 2000 F. It is reheated to pouring temperature, about 2150 F, and poured immediately. Super heating and long holding favors burning away of the beryllium, and contamination with the furnace gases. An exothermic riser compound is used immediately after pouring the metal to provide a hot top in the open risers. The castings are then permitted to cool to about 1000 F for shakeout.

After a careful cleaning, the castings are given a solution heat treatment at 1550 F for 2 hr. or more, depending upon the size of the casting. A cold-water directional quench follows, and a precipitation treatment completes the process. Precipitation is carried out at 870 to 900 F for about 3 to 4 hr., the time and temperature depending upon various conditions.

The copper-alloy castings made by this procedure will have the following properties:

Electrical conductivity ...	55% of standard copper
Tensile strength	70,000 to 75,000 psi., average
Yield strength (1/100 in. in 2 in.)	45,000 to 48,000 psi.
Elongation	10 to 13%
Density	0.32 lb. per cu. in.
Hardness	85 to 90 Rockwell B

When the design requirements are such that electrical conductivity must be higher than is possible to obtain with the strong alloy, the parts may be cast of high-conductivity copper. In this case the charge consists of electrolytic copper only, with about 2 oz. of phos-copper added to deoxidize the melt. The phos-copper is about 15% phosphorus. After melt-down, lithium-copper is added, as in the case of the beryllium alloy, and a purge with nitrogen follows.

Pouring is done as with the alloy, and the copper comes out of the molds dead soft, due to the complete annealing in the molds. Physical properties are about as follows:

Tensile strength	25,000 psi.
Elongation	50%
Hardness	30 Brinell (500 kg. load, 10 mm. ball)
Electrical conductivity ..	80 to 90% of standard copper

While electrical conductivity will fall within the 80 to 90% range, it is controllable within that range to some extent. If a conductivity of about 90% is required, deoxidization with phos-copper is omitted and especial care is taken to avoid contamination of the metal.

If the design requirements dictate the use of high-conductivity copper, but the member must still carry stresses, the piece is made larger than a similar member of beryllium-copper alloy.

A portion of the molding department at Warren Foundry. The open flask shows a mold for a large, portable welding gun.

Shot Blasting Replaces Pickling on Some Steel Cleaning Applications

by KENNETH ROSE,

Western Editor, Materials & Methods

Where applicable, blast cleaning saves cost and space over the usual pickling set-ups.

WHEN THE SURFACE of iron or steel pieces must be cleaned in preparation for processing, pickling in acid is one of the standard procedures. Acid pickling is an effective method of removing an oxide film from the metallic surface, leaving a clean area for heat treating, forming, forging, machining, plating, etc. Recently it has been found that another process, blast cleaning, overlaps many of these same fields of metal preparation. Several important installations now in successful operation show that the engineer concerned with the cleaning of metal and other surfaces as a preliminary to further processing will do well to consider whether blast cleaning might meet his needs more economically than some of the other, more orthodox methods.

A proponent of this newer phase of blast cleaning is American Wheelabrator & Equipment Corp., which has had long experience in the production of blast cleaning equipment for industry. The Wheelabrator cleans by the abrasive action of a stream of very small pellets, usually of chilled iron, propelled by the centrifugal force of a rapidly rotating impeller. There is no air blast. While blast cleaning has shown substantial cost savings over pickling in those cases where a careful cost analysis has been made, it must not be assumed that this method of surface treatment is capable of replacing pickling in all applications. The two methods have a zone of overlapping utility, and it is in this zone that the engineer should consider both costwise.

It is well to consider at once some of the circumstances in which blast cleaning is and is not effective, so that its field can be more clearly defined. Here they are:

1—Blast cleaning can be used efficiently only when the material to be removed is hard and dry.

2—If grease, oil, or tar contaminate the surface, a degreasing process must precede blast cleaning.

3—Any tacky surface contaminant will attach itself to the abrasive, and will prevent satisfactory operation of the machine.

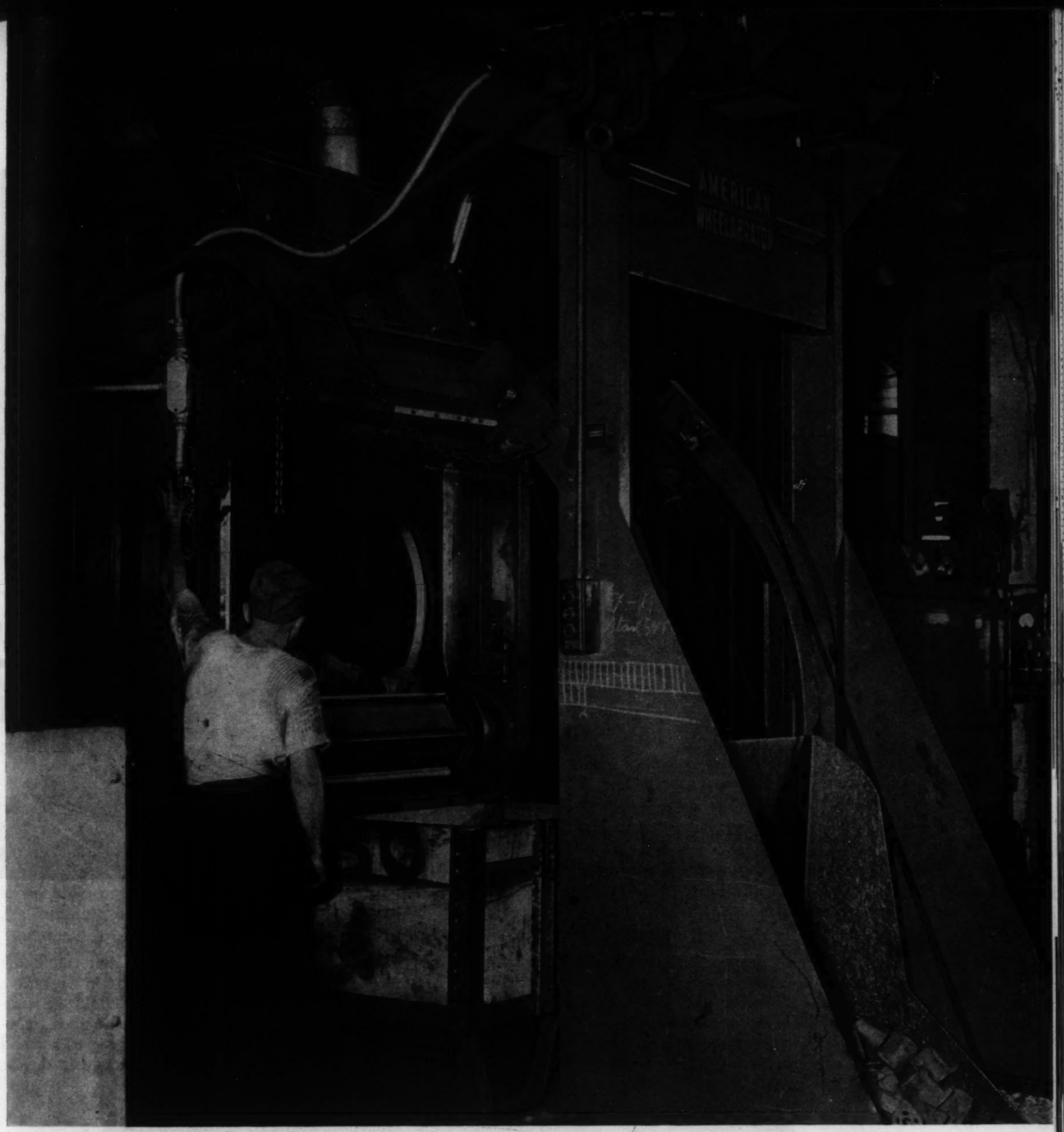
4—With surfaces other than iron or steel, the problem of contamination of the surface with iron dust must be considered. This is not necessarily a bar, as several methods to control this contamination are possible, but it is a point that must be given consideration when planning a cleaning department.

The fields of use in which blast cleaning has successfully competed with pickling include the following:

1—For cleaning rough castings. Cleaning is here intended to remove adhering sand as well as oxide scale. As an abrasive cleaning of some type frequently precedes the pickling, a single blast cleaning that will prepare the castings for further work has an obvious advantage.

2—For cleaning finished work for reconditioning or repair. If the piece is of such nature that blast cleaning will not mar machined surfaces, the method will usually remove adhering dirt, rust, or old paint economically.

3—For cleaning preliminary to electroplating galvanizing, hot dip coating, or metallizing. When electroplating is to be used, blast cleaning produces a clean metallic surface without the danger of occluded hydrogen. The cleaning must be done with fine grit, however, if a smooth surface is to result. In the case of any of the other coating processes, a coarser grit will roughen the surface slightly, and so will clean and condition the surface at the same time.



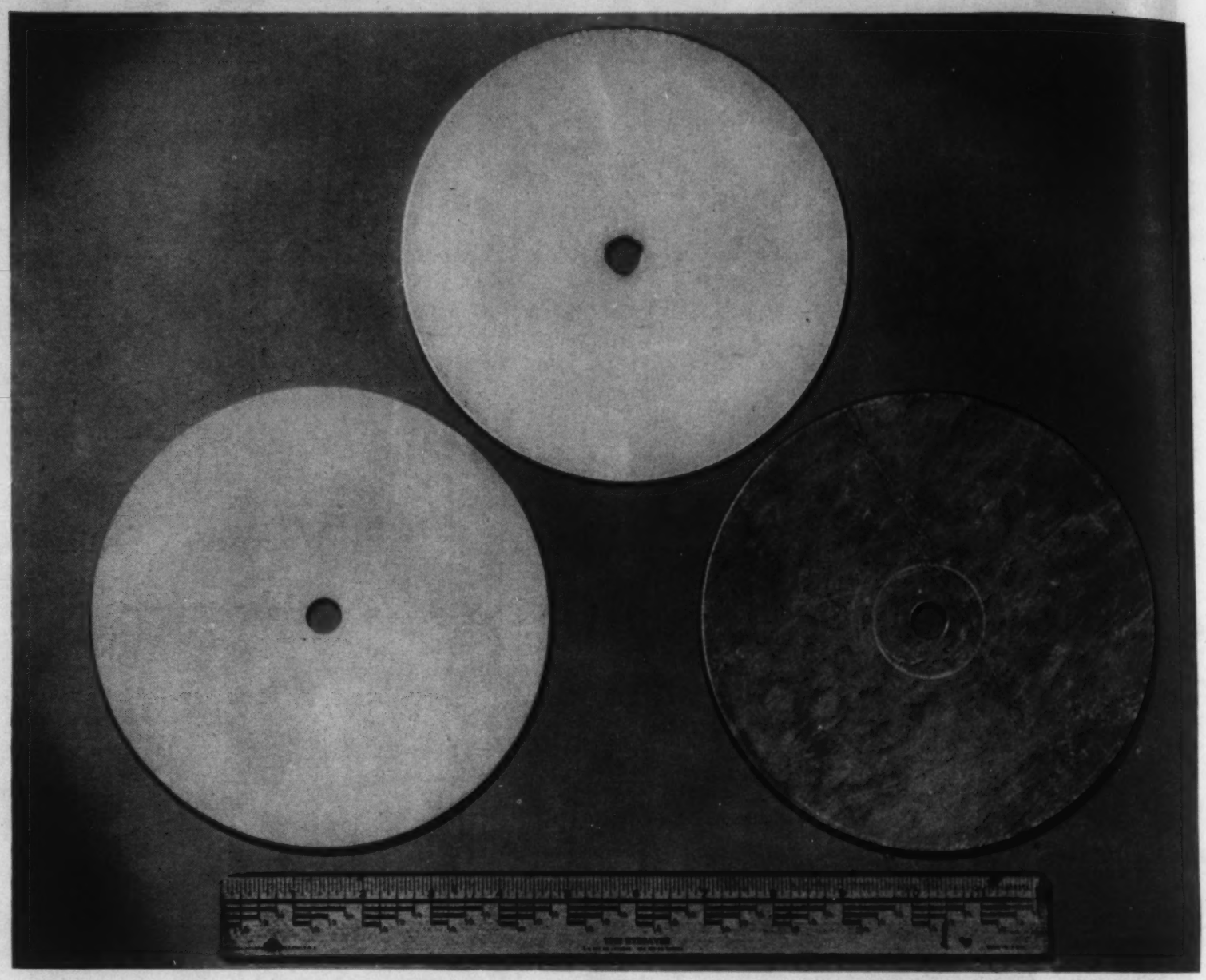
Rotary tumbling and blasting equipment in use at Iroquois Foundry Co., Racine, Wis., handles heavy parts.

4—For cleaning strip or sheet before cold rolling. While blast cleaning does a rapid, economical job, it is occasionally desirable to follow it with a brief 20- to 30-sec. pickle to remove iron dust from the metal surface. This is especially true in the case of stainless steel, where the iron dust would seriously contaminate the surface.

Several additional surface treatments in which blast cleaning is used, though not strictly as a substitute for pickling, might be mentioned here. They include the preparation of steel surfaces for rubberizing, the cleaning of molded rubber articles to eliminate mica or other mold release agents in preparation for adhesive bonding, blasting to remove fins or flash from die cast or die forged pieces, blasting of plastics parts to roughen surfaces for cementing or bonding; to remove flash; or, to produce a frosted effect in clear plastics; and finally, the treatment of glass to produce a frosted effect.

The machine itself is quite simple in its working parts. The abrasive is collected in a hopper under the work, is carried by a bucket conveyor to an overhead separator where it is cleaned, then passes into a storage hopper. Gravity feed carries it to the im-

Three views of pressure cooker lids finished for plating by shot blasting. Lower right shows the piece before cleaning, left shows after cleaning, and the piece above after plating.



peller wheel as required. The amount of abrasive fed to each vane of the impeller is controlled by a stationary cage at the center of the wheel, the control cage measuring the abrasive and delivering the proper quantity to the bladed sections of the wheel. The wheel is 19½ in. in dia. and revolves at a speed of 2250 rpm., giving it a tip velocity of 14,000 ft. per min. About 300 lb. of chilled iron shot or grit travelling at this velocity is flung at the material being blasted each minute that the machine is in operation.

While the intensity of the blast could be controlled by regulating the fineness of the shot, regulating the speed of the wheel, or changing to a wheel of different diameter, it is general practice to do the

S.A.E. Abrasive Sizes Recommended for Most Effective Blast Cleaning

Type of Abrasive	Castings									Forgings				Prior to Galvanizing or Plating	
	Cast Iron			Malleable		Steel		Brass		Alum.	Mag.	Large	Small, Medium	Castings	Stampings
	Large		Medium Small	Large	Medium Small	Large	Small, Medium	Large	Medium Small						
	With cores	Surface sand only													
Shot	S460 S390	S390 S330	S330 S230	S390 —	S230 —	S460 —	S390 S330	S230 S170	— —	— —	— —	S390 S330	S110 —	— —	— —
Grit	G16 G18	G18 G25	G25 G40	G18 —	G25 G40	G16 —	G18 G25	G40 G50	G50 —	G50 G120	G120 G200	G25 G40	G50 —	G40 G120	G50 G200

regulating by use of shot size only. Coarser grades of shot give quicker cleaning, but a rougher finish results. Harder materials can use the coarser grades without excessive denting of the surface, however. For many purposes the rougher finish is not objectionable, as when the metal is to be coated with asphalt; in some cases it is desirable, as in metallizing. When a smooth surface is needed, as in electroplating, or when soft metals are being cleaned, a fine abrasive should be used.

The abrasive is usually chilled iron shot or grit. At times, however, it is desirable to use another abrasive in the machine. These include:

1—Malleablized iron shot. This material is receiving increased usage in blast cleaning. It is more expensive than chilled iron, but does not break down as quickly, and causes less wear on the equipment.

2—Steel shot. Used at present in very limited quantity only, and only for peening, steel shot lasts longer and is easier on the blast machine.

3—Other metallic abrasives. These may be copper shot, copper turnings, or stainless steel shot. They are usually made up by the user of the equipment, and are intended to avoid contamination of the work with iron dust.

4—Nonmetallic abrasives. Sand, aluminum oxide, silicon carbide, plastic pellets, walnut shells, bran, corn meal, etc., are used for special purposes, such as the cleaning of plastics or obtaining a very fine surface with soft metals.

The blast cleaning unit can be adapted to either batch or continuous operation. For batch operations tumbling of the work is accomplished by steel slats or a rubber belt, permitting the blast to reach all surfaces of each piece. The work must be sufficiently durable to withstand the tumbling, and should be reasonably compact. The size range of pieces suitable for tumbling is very wide. Continuous blast cleaning may make use of the table type of equipment, loaded and unloaded manually, or of special cabinets built into a production line. Tables are useful for fragile work that cannot be tumbled, for flat pieces, and, in the multi-table or swing table types, for pieces with intricate cavities, or awkwardly shaped work, or for pieces of heterogeneous sizes.

As compared to pickling, blast cleaning offers the following advantages: 1—No waste disposal problem is created, as with the spent acid; 2—blast cleaning equipment requires considerably less floor space than pickle tanks and wash water tanks; 3—there is no health hazard; 4—the danger of hydrogen embrittlement of steel is eliminated; 5—no carbon smut is left on the surface of the metal; 6—there is no appreciable metal loss in proper operation; 7—surface improvement by peening may be an advantage; 8—the equipment is more versatile.

A large steel company estimated the cost of an installation for blast cleaning steel strip at $250,000. The company's estimate for a comparable pickling line was $1,500,000.

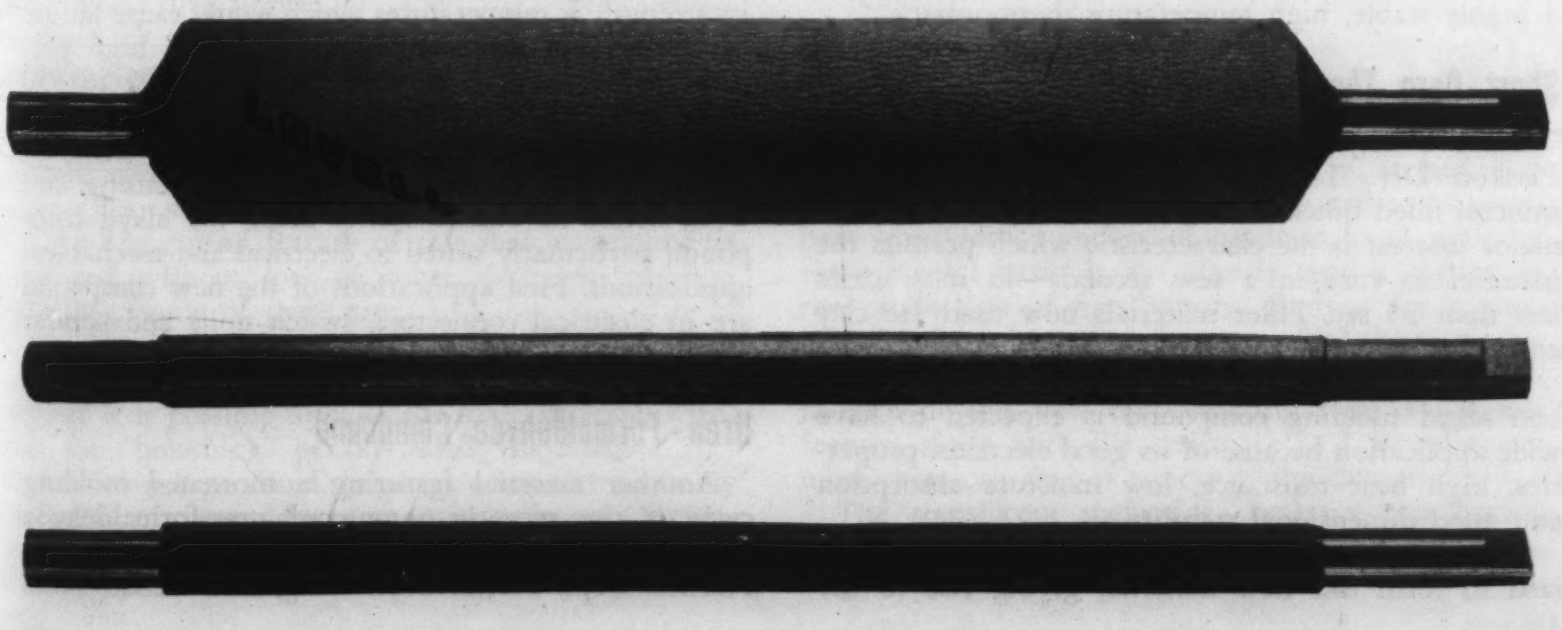
In the preparation of hardware, hand tools, etc., for japanning, blast cleaning is now being used successfully. Similar preparation of metal surfaces for coatings, such as asphalt coating of pipe lines and resinous coating of steel drums, is being done by blast cleaning.

The added advantage of roughening of the metal surface in addition to cleaning it is shown in the use of blast cleaning for brake shoes when brake bands are to be bonded to them by adhesives instead of being riveted on. The metal shafts for wringer rolls and for printer rolls are similarly blast cleaned and roughened to permit best bonding to rubber.

The Draper Corp., Hopedale, Mass., uses leather on certain of its steel loom parts. Bonding of the leather to the metal is assisted by blast cleaning and roughening of the steel.

As an illustration of the versatility of the uses of the process, the A. G. Spaulding Co., manufacturers of sporting goods, found that they could greatly increase the effectiveness of the bond between the leather layers of basketballs by roughening the leather slightly. Blast cleaning proved to be the cheapest and best means of doing the job.

Shafts for wringer rolls are cleaned by Wheelabrating. At the bottom is an unfinished shaft; in the center the cleaned shaft; at the top the finished wringer with the rubber bonded to the shaft.



New Plastics Offer Wide Range of Properties and Fabricating Characteristics

— NEW MATERIALS PREVIEW

SEVERAL NEW PLASTICS MATERIALS were announced prior to, during and immediately after the recent Plastics Exposition in New York. All of the materials are designed to provide properties that are desirable but heretofore unattainable in the plastics families into which these new plastics fall. Those to be described here include a new alkyd molding compound with remarkably short curing cycle; a urea-formaldehyde compound with a shortened molding cycle; a high heat-resistant polystyrene; and, a highly stable, high temperature thermoplastic.

Short Cure Thermosetting Resin

Plaskon alkyd molding compound, developed by Plaskon Div., Libbey-Owens-Ford Glass Co., is a mineral filled quick setting thermosetting plastic. Of major interest is the characteristic which permits the material to cure in a few seconds—in most cases less than 25 sec. Filler materials now used are clay and asbestos.

In addition to its quick setting characteristic, Plaskon alkyd molding compound is expected to have wide application because of its good electrical properties, high heat resistance, low moisture absorption and good dimensional stability.

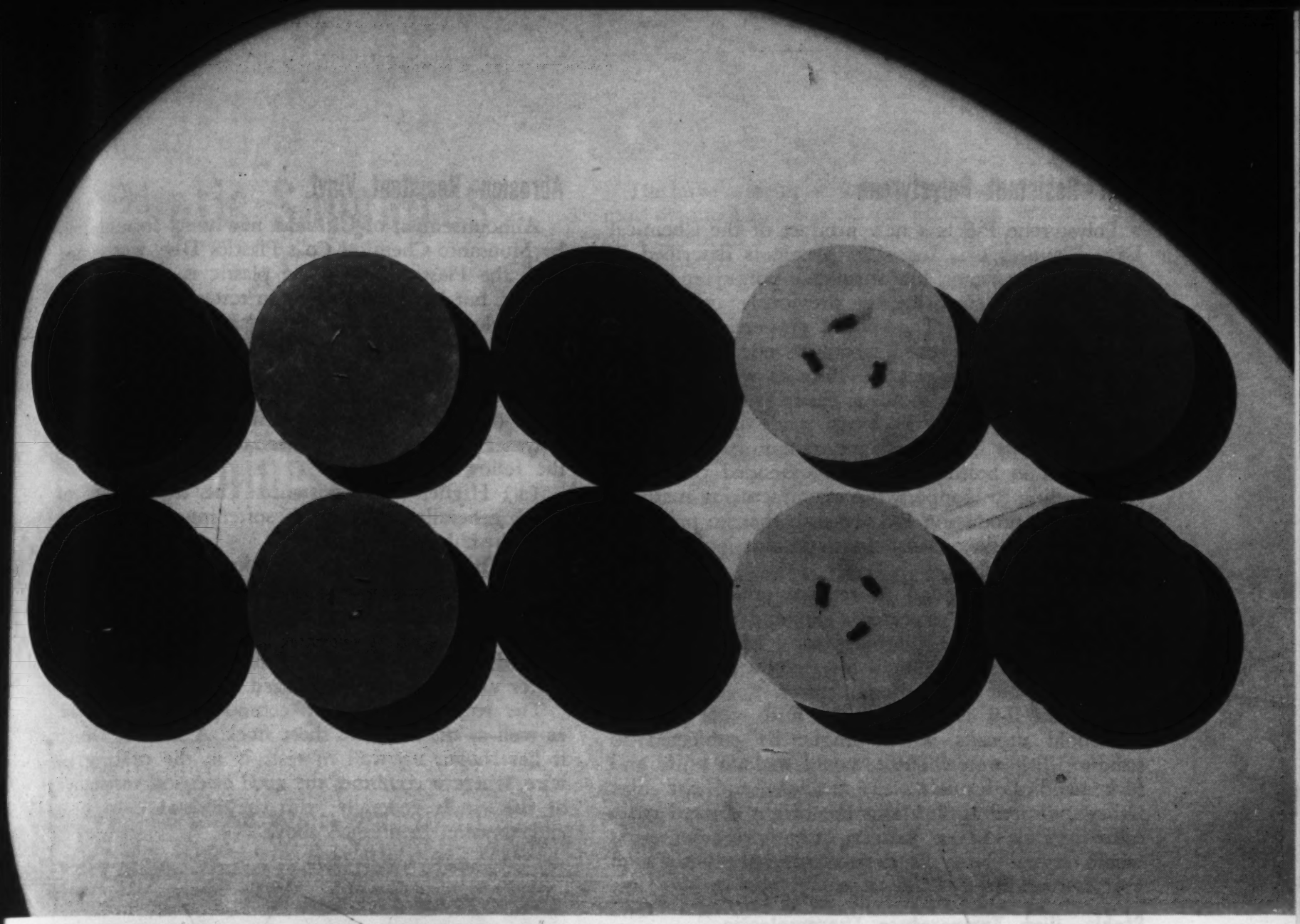
Light, high-speed molding machines can be utilized to form this new material, giving rise to the possibility of broadening the field of plastics utilization. Pressures required vary from 400 to 2,000 psi., depending upon the piece.

Plaskon alkyd molding material differs from other older materials of the same general class in that tensile, flexural, and compressive strengths are somewhat less than for cellulose-filled thermosetting plastics. The reduced mechanical strengths are due to the mineral fillers used. On the other hand, the heat resistance of the alkyd compound permits it to retain its strength at temperatures which would cause failure of comparable materials. Moldings retain high percentages of strength at temperatures of 300 to 350 F for extended periods.

Parts molded of the alkyd material are resistant to all common organic solvents and to strong and weak acids. Its characteristics make the alkyd compound particularly suited to electrical and mechanical applications. First applications of the new compound are in electrical connectors, switch units and similar parts.

Urea - Formaldehyde Compound

Another material featuring a shortened molding cycle is the recently announced urea-formaldehyde molding compound of American Cyanamid Co.'s Plastics Dept. It has been designated Beetle Med.



One of the outstanding properties of the alkyd molding compound developed by Plaskon is its arc resistance. Shown here are disks made from various plastics, all of which were exposed under an electric arc for 165 sec. under identical conditions. The alkyd disk, top right, did not fail in this period, while the other materials failed in periods ranging from 10 to 132 sec. The tests were repeated (bottom row) after soaking samples in water for 72 hr.

(FC) to indicate its relationship to the company's well known line of molded articles offered under the name of Beetleware, with the "FC" added to call attention to its fast cure.

Laboratory and field test results show that the cure time may be about half that of the standard urea plastics. Under carefully controlled processing the production rate has risen to almost double the former rate. Such a gain can be obtained only when (1) fast-acting presses are used, (2) prewarming is carefully regulated, (3) molds are kept in good condition, and (4) operating personnel is properly instructed. Prewarming temperatures become more critical at the faster rates of operation, and must be closely controlled. In the mold itself, several bad cavities can slow down the press production rate.

The fast curing feature of this new compound is obtained without loss of other desirable molding qualities. Some of these are:

Quick closing time. There is less gas formation with the new compound. For the molding of some shapes it is possible to close the mold directly, without the "breathing" period usually required.

Low shrinkage. Mold shrinkage compares favorably with that of the standard compositions in urea formulations.

Good finish. Finish of the pieces as they come from the mold shows a substantial improvement over that of similar pieces in earlier compositions.

Stability. The molding compound possesses a stability comparable to that of other formulations of ureas.

Runs have been made upon such articles as clock cases, radio cabinets, closures, watch boxes, electric shaver cases, and buttons, with success both in the molding and in the end use of the product.

Melamine - Formaldehyde Material

A thermosetting resin of high translucency has been produced in the melamine-formaldehyde group. A product of American Cyanamid Co., it has been designated Melmac 404. While it is still too new to have gone into a variety of products, even upon an experimental basis, it has already won a market in the production of fine buttons. Buttons for higher-priced men's shirts and ornamental buttons for women's clothing have found in the pearly translucence of this new thermosetting resin a valuable feature, along with the resistance to hot water and most chemicals that is typical of the thermosets.

The translucent melamine combines this optical quality with good strength and good resistance to impact. It is a premium-priced material.

Heat - Resistant Polystyrene

Polystyrene P-8 is a new product of the Chemical Div., Koppers Co., Inc. The plastic is described as a high heat-resistant, low shrinkage polystyrene offering three characteristics not previously available in this type of plastic. The special properties are: (1) It is the first heat-resistant polystyrene that can be molded into a glass-clear product as well as in any desired color; (2) it molds as easily as regular grades of polystyrene; and (3) when made in colors, the material shows high resistance to fading, even when submersed in boiling water for extended periods.

According to Koppers, the manufacturing methods involved in producing P-8 are such that no premium price is necessary. Most heat-resistant polystyrenes demand a premium.

P-8 is not intended to replace other grades of polystyrene, but is expected to extend the range of application of these thermoplastics. Molding cycles are as short or shorter than for general purpose type polystyrene, but cure time is shorter.

Koppers P-8 is expected to find wide use for household utensils which might be subjected to scalding dish water. These would include knife and fork handles, funnels, tea strainers, and the like. Other indicated applications are bright colored radio cabinets and storage battery cases and other parts where crystal-clarity is desired together with high heat resistance.

Stable, High Temperature Thermoplastic

An interesting new thermoplastic is available in limited quantities from the M. W. Kellogg Co. Known as Kel-F, the material offers high temperature properties, stability of physical properties over a wide temperature range, and inertness to chemical attack. It can be formed by compression, transfer and injection molding as well as by extrusion. It has been made in the form of sheets, films, tubing, rod and shaped pieces.

Extensive tests indicate that Kel-F has satisfactory properties at temperatures between −320 F and 390 F, a range of over 700 F. The material has a low cold flow factor, excellent water resistance, and acts as both an electrical and heat insulator. It can be punched, drilled and machined to close tolerances.

Heat treatment can be used to vary the properties of Kel-F. Stable properties at use temperatures are obtained by heat treating at higher temperatures. By heat treatment, the material can be made relatively soft and resilient, resembling a plasticized material, or harder and less yielding, without sacrifice of stability properties.

Kel-F is said to have high impact strength at low temperatures and to be resistant to thermal shock.

Expected uses for Kel-F are for such products as pump and valve packings and valve seats for use with corrosive liquids and gases; gages in place of glass in flow meters; laboratory tubing; electrical insulation; air and gas pressure safety valves; and similar types of applications where the material is likely to encounter dampness, relatively high temperatures and corrosive media.

Abrasion - Resistant Vinyl

Announcement of Ultron, a new vinyl formulation by Monsanto Chemical Co.'s Plastics Div., was timed with the Plastics Show. The plastic is still in short supply, but has been proved in test applications and in development. Commercial quantities are available in film form, and as sheeting.

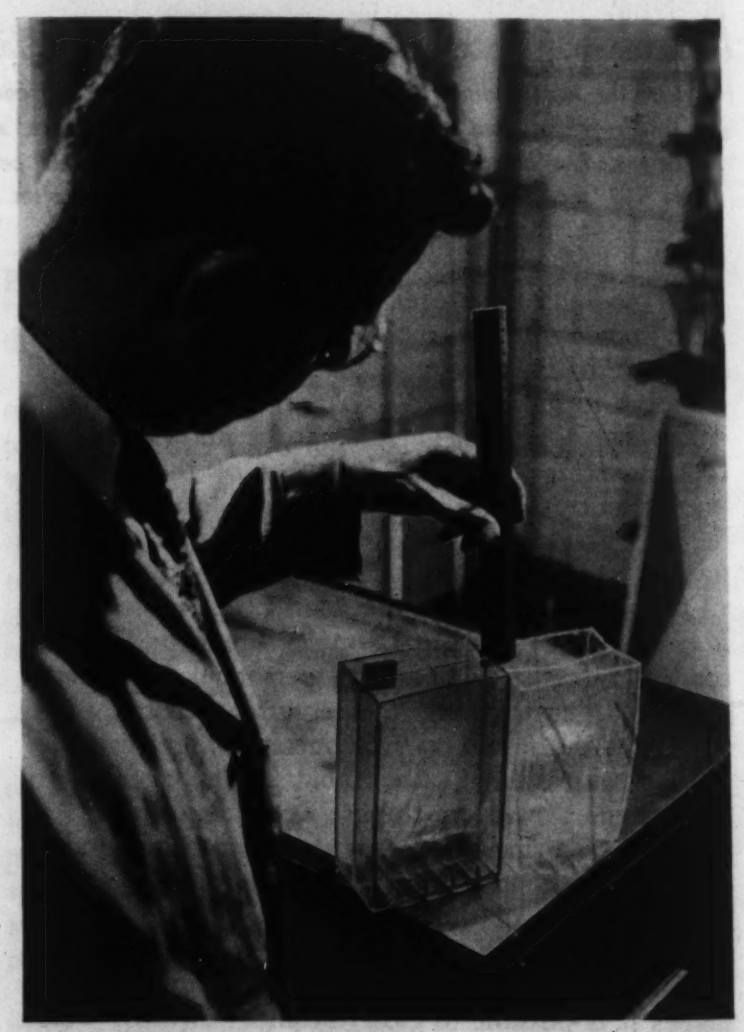
Ultron is a straight polymer of vinyl chloride, with suitable quantities of plasticizer added for development of special properties. This use of the straight polymer instead of copolymerization gives the resin the following advantages:

(1) Higher heat resistance. The copolymers of vinyl generally have lower softening temperatures than the chloride polymer.

(2) Better resistance to chemical attack. While the decreased solubility in chemicals is not always an advantage, the property is available when desired.

(3) Higher abrasion resistance. The straight resin is harder and more resistant to scuffing. It is also stiffer unless suitably plasticized.

The resin and the resin compound are available, as well as the film and sheet stock. A field in which it has shown up well in tests is in the coating of wire, where it combines the good electrical resistance of the vinyls generally with the resistance to heat and abrasion mentioned above.



The heat-resistant polystyrene P-8 made by Koppers Co. withstands boiling water. Here are compared general purpose polystyrene and the new P-8, both of which were tested in boiling water. As can be seen, the general purpose material was badly deformed.

Synthetic Sapphires Provide High Finish for Machine Parts

by N. BRUCE BAGGER,
Associate Editor, Materials & Methods

Surpassed in hardness only by diamonds, these man-made gems for industry are excellent wearing, bearing, or cutting materials.

GEMS HAVE ALWAYS HELD AN ALLURE. Since earliest recorded history, mankind sought these glittering baubles as outward signs of wealth and power. But the ancients little realized the potential power that lay beneath the surface of their precious stones. Today, these gem materials, now man-made, provide industry with its most valuable tools, their value far exceeding that of by-gone treasure troves.

Among these industrial gems are synthetic white sapphires—unicrystalline forms of aluminum oxide. These gems are extremely hard and wear-resistant, and can be finished to exceptionally smooth surfaces. The sapphire's hardness rating of 9 on Mohs' scale compares favorably with that of the diamond at 10. When bonded to metals, sapphires provide wear-free faces for machining, gaging, and bearing uses.

Typical of these industrial uses of synthetic white sapphires is the finish work done on spectrophotometer defining jaws at National Technical Laboratories, South Pasadena, Calif. The material used in these jaws is known as engraver's brass, high in lead content. Prior to finishing, the jaw blanks are cut, milled, and lapped to extremely close tolerances for flatness and parallelism. With this done, the final finishing operation takes place.

The lathe is set up with both roughing and finishing tools mounted in a special face plate, the tools turning on a radius of 2 27/64 in. A spindle speed of 1400 rpm. is used. This develops a peripheral speed of approximately 1775 sfpm. The work is held in two jigs mounted on the cross-feed compound, each jig on either side of, and equidistant from the bed center. Each jig holds 16 jaw blanks with a waste piece on either end. The jigs are designed to stagger the blanks at an angle of 10 deg. 5 min. The compound is set for a travel 5 deg. off the normal. This set-up develops a radius of 27.9 in. on the machined edge of the blank at an angle of 85 deg. It also generates a convex surface on one set of blanks and a concave surface on the opposite set.

The rough cuts are made with a standard tool. Each pass is about 0.010 in. deep. When the blanks are within 0.0012 in. of the finished dimension, the roughing tool is removed. The finish cuts are then made with the sapphire tool. Only four passes are necessary with this: two of 0.0005 in., one of 0.0002 in., and a final burnishing pass with the same tool setting. This gives a surface finish of approximately 5 microinches.

A diamond tool is the only other means of obtaining a finish such as this. While the finish of the sapphire is slightly less than that of the diamond, it is entirely satisfactory for the precise work handled by the completed instrument in which the jaws are used. Diamonds, it was found, chipped considerably and resulted in an unsatisfactory cut. This, coupled with the higher initial cost and greater resharpening expense, made them a less satisfactory tool. The use of tungsten carbide and high-speed steels did not produce a good finish. These latter tools left a fine wire edge on the jaws, making it impossible to get a light-tight closure in the finished instrument.

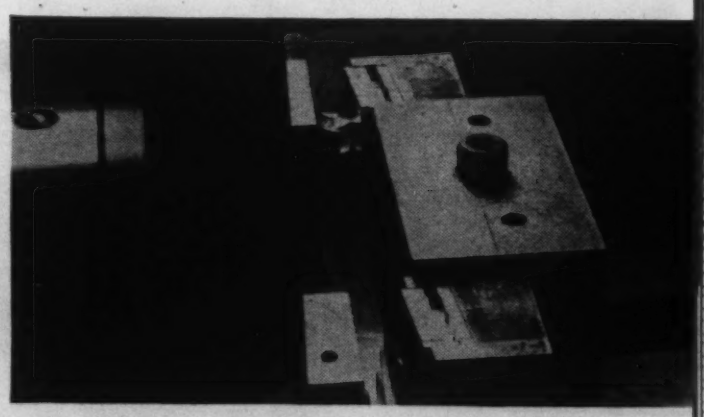
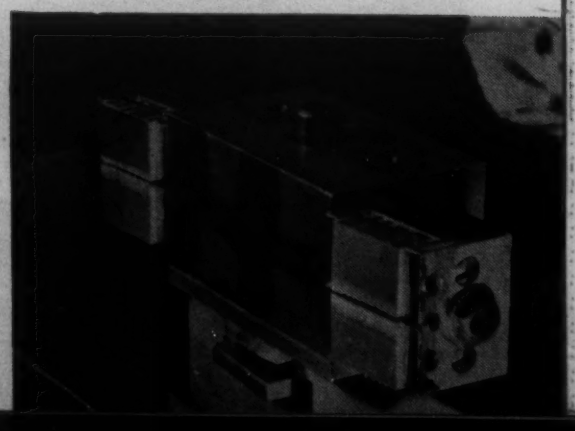


Fig. 1—General view of lathe set-up during finishing operation.

Fig. 2—Detail of sapphire tool showing method of mounting.

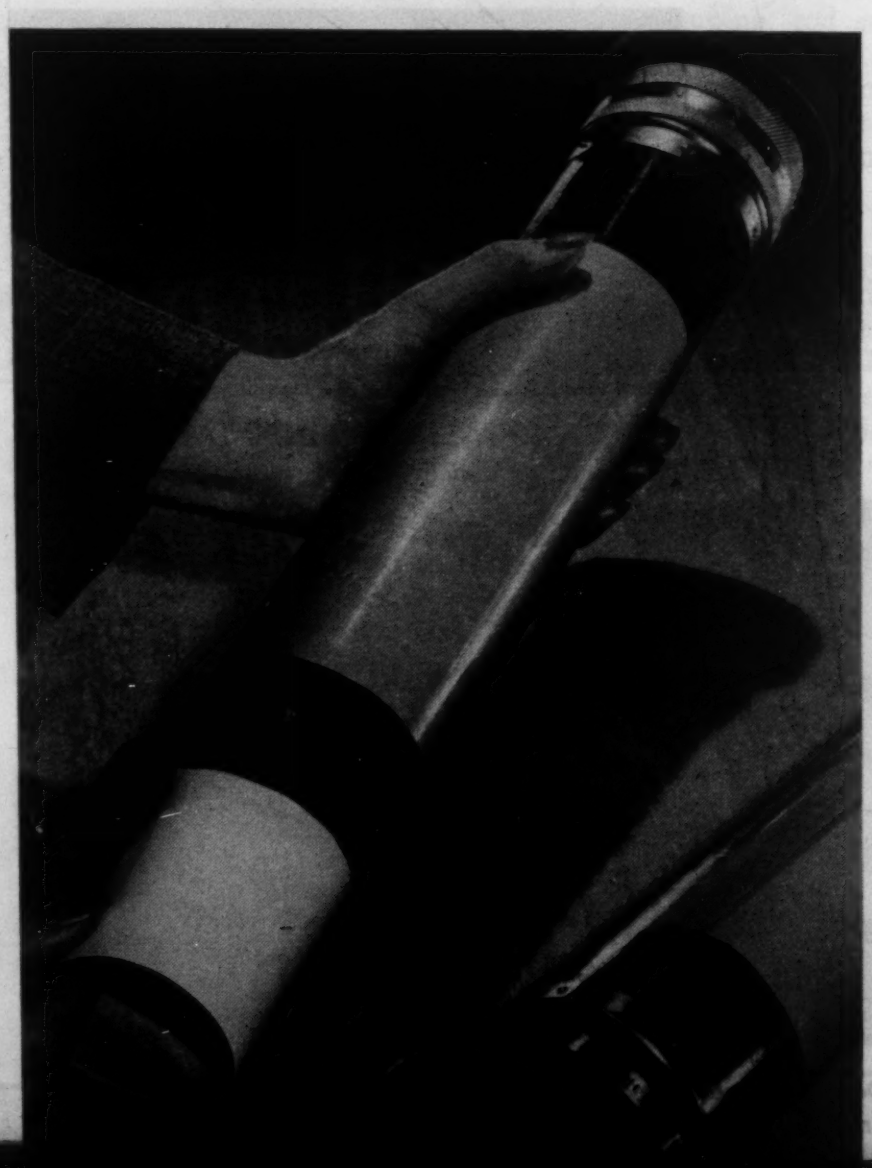
Fig. 3—Detail of jaw blanks in jigs after final finishing.



Materials

CELLULOSE ACETATE BUTYRATE KEYS

Continued use cannot obliterate the numerals from the keys of this Victor Portable Subtractor. Double-molded in two contrasting colors, the Tenite keys are produced by the Electric Manufacturing Co., San Francisco, Calif. Numerals are molded flush with the key surface to eliminate dirt-catching depressions; no filling or wiping with paint is required. The key-molding process is extremely rapid, and the dies produce a high natural luster on the finished product.

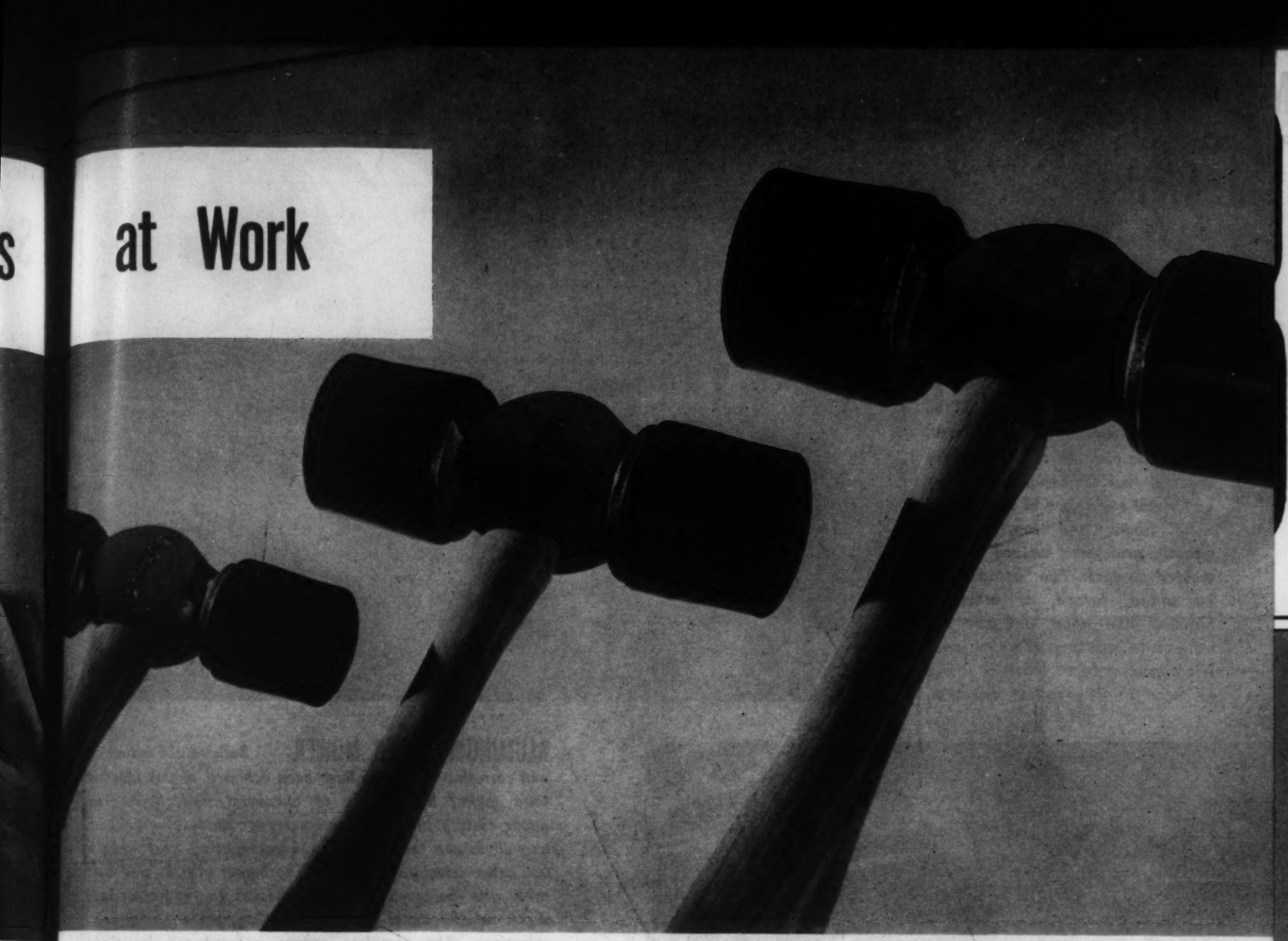


CELLULOSE ACETATE BUTYRATE CARRIERS

Transparent Tenite tubing replaces the opaque fiber midsections of carriers in pneumatic-tube systems. These carriers, a product of Standard Conveyor Co., North St. Paul, Minn., are made by cementing and riveting double-ring indicators and leather covers on either end of the extruded, seamless tube. The plastic, in addition to providing transparency to speed dispatching, has high impact strength to withstand the normal abuse encountered in this type of service.

Here is materials engineering in action . . . New materials in their intended uses . . . Older, basic materials in new applications . . .

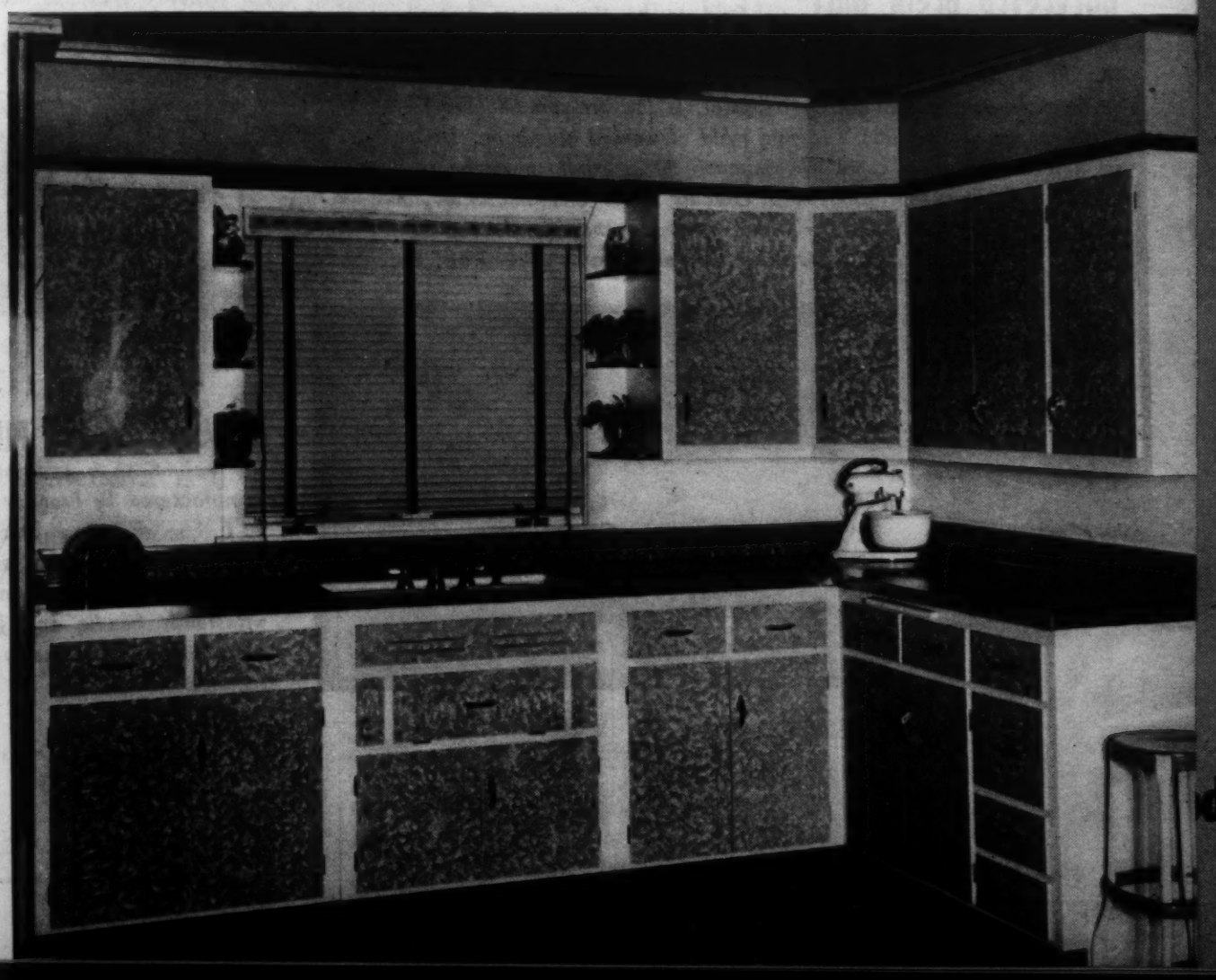
at Work



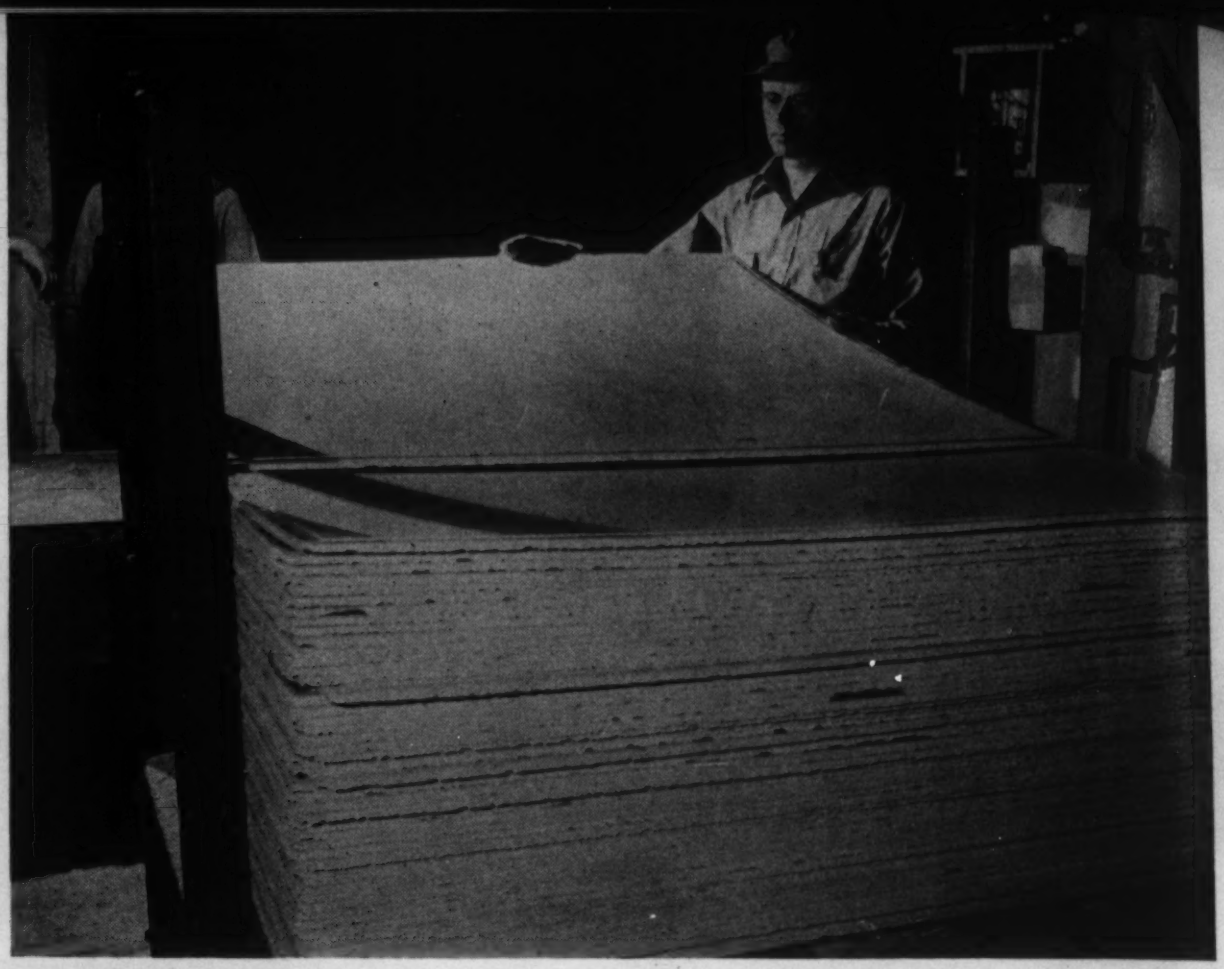
VINYLITE-FACED HAMMERS *Fastened to drop forged heads, these specially compounded elastomeric Vinylite striking faces provide the driving power of standard machinist hammers of equal weight. The hammers, produced by the Vlchek Tool Co., Cleveland, Ohio, can be used without marring easily damaged surfaces. Shop-testing and exposure to corrosive chemicals in lead acid tanks and vats reportedly leave the hammer heads unaffected by impact or deterioration.*

SYNTHETIC RESIN-BONDED PANELS

Laminated plastic sheets, conventionally used for table and bench tops, are now practicable for drawer and door fronts as well. The sheets, produced by Farley & Loetscher Mfg. Co., Dubuque, Iowa, are bonded with thermo-setting synthetic resins under high heat and pressure. Permanent designs or solid colors are incorporated into the top surface and protected from wear by a translucent resin overlay. Inlays can be molded flush into the sheets. The paneling withstands temperatures to 275 F, and is resistant to water absorption, delamination, warping, and chipping.

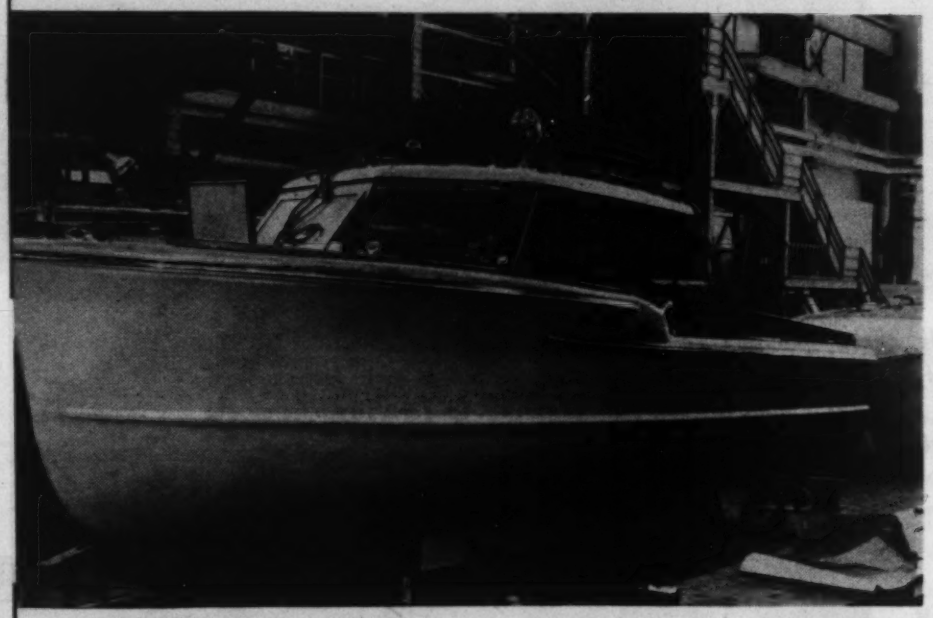


Materials at Work



MAN-MADE LUMBER

Sawdust, woodchips, and Monsanto's Resinox are combined under 300 to 350 F heat and 200-lb. pressure to produce millwork paneling by the Curtis Companies, Inc. of Clinton, Iowa. The phenolic resin binder increases the dimensional stability and water resistance of the natural wood fibers, and results in a smooth, grain-free surface for the molded product. The "boards" can be sawed, turned, or otherwise handled like wood, and are not subject to splitting. The material is claimed to be at least as strong as wood in its weakest direction.



POLYESTER RESIN HULL

Said to be the largest one-piece molded plastics item, this 28-ft. personnel boat has been completed for the U. S. Navy. The 2600-lb. hull, of polyester resin with glass fiber mats as the laminating material, is low-pressure molded in a huge rubber bag against a female mold of welded aluminum. Savings in hull construction costs approximate 90%. Hull maintenance is eliminated, and the dangers of teredo worm and bacteriological attack greatly reduced. The first order for these craft has been placed with Winner Manufacturing Co. and Marco Chemicals, Inc.

ALUMINUM POWER MOWER

Both weight reduction and corrosion resistance have been achieved in this electric lawn mower by the use of aluminum throughout. The motor castings and machined parts are made of aluminum as well as the tubing handles, sheet housing, cast wheels, and other structural members. The mower utilizes a V-belt drive with balanced aluminum sheaves to reduce impact shock on the motor when the cutting blade strikes obstructions. The complete mower is produced by Vogt Brothers Manufacturing Co., Louisville, Ky.

ALUMINUM ALLOY PIPE WRENCH

Less than half the weight of a conventional pipe wrench, this unit is manufactured by Frontier Bronze Corp. of aluminum alloy 40-E. The alloy requires no heat treatment, machines well, has high yield strength and excellent corrosion and shock resistance. In the 18-in. size, this wrench repeatedly withstands handle and jaw loads of 13,500 in.-lb. Replaceable steel inserts in the jaws simplify wrench maintenance.

MATERIALS & METHODS MANUAL

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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Metal Cleaning

by T. C. Du Mond, Managing Editor,
Materials & Methods

One of the most important, and sometimes the most neglected, processes in metalworking is that of cleaning. Cleaning is not merely a final step preparatory to further finishing, it is important between other manufacturing steps. This manual is intended to show the basic differences between widely used cleaning methods, and to point out how they can be applied to the various metals.

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November 1948

Materials & Methods

Introduction

At a glance, it would appear that metal cleaning should be a relatively simple matter. It is not. There are probably more variables in removing the unwanted surface matters from metals than are present in any other processing step.

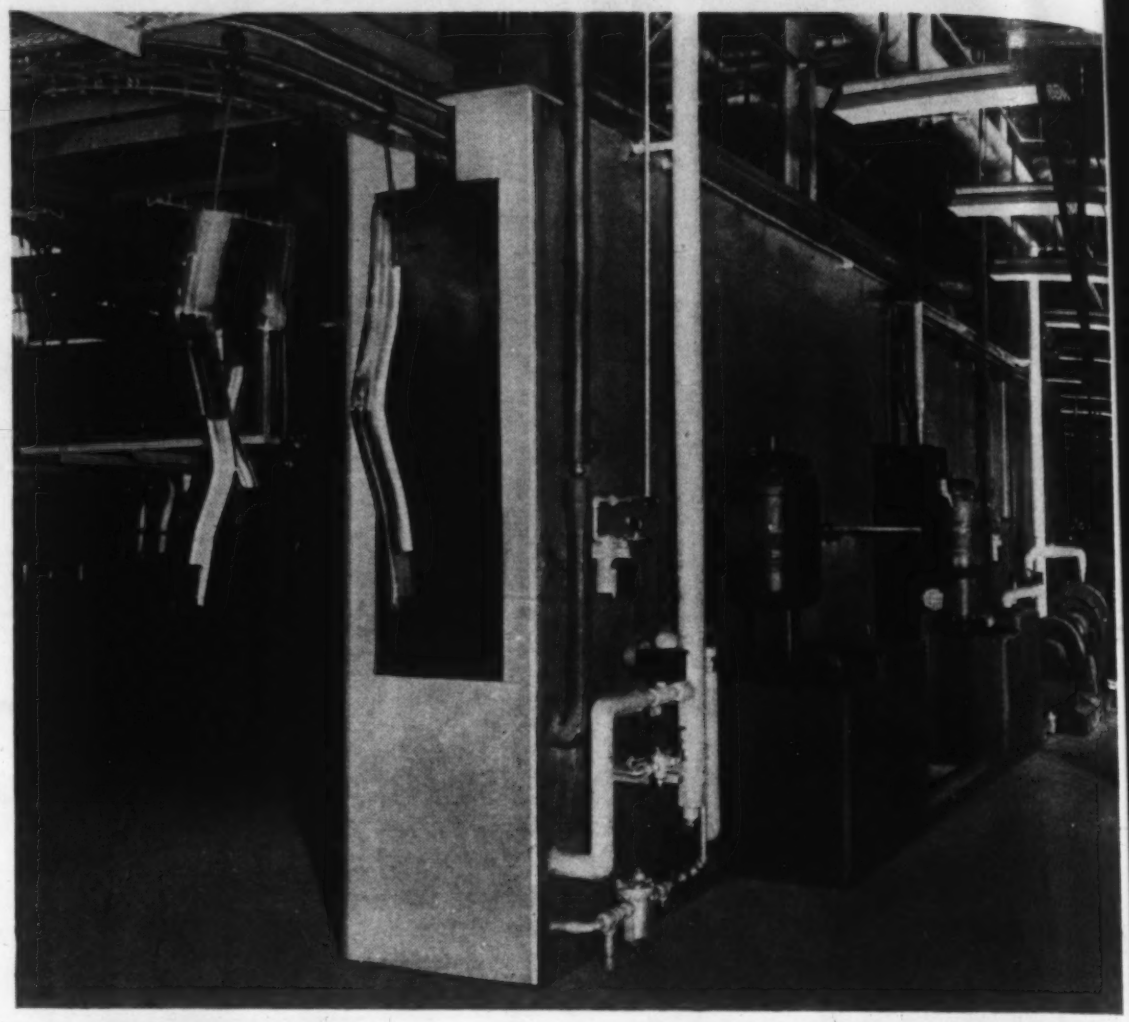
The most important elements in cleaning are the material to be cleaned, the contaminant to be removed, how tightly the contaminant adheres, and what, if any, further surface treatments are planned.

On certain types of parts which must pass through a wide range of manufacturing operations, cleaning may enter the picture many times. There is a possibility that each cleaning step will involve a different treatment than its predecessor.

To illustrate how complex the selection of a cleaning method can be, it is necessary to realize that there are more than a dozen cleaning methods; at least as many "soils" which may need removing; and, 10 or 12 broad metal groups. Each combination offers a differing problem.

A further consideration in choosing a metal cleaning method is the degree of cleanliness required, coupled with how dirty the surface might be. For instance, the removal of cutting oil from a machined piece prior to gaging or inspection can be a simple matter. On the other hand, the same piece after heat treating and grinding and polishing might be destined for plating. In this case, the surface must be chemically clean and require a cleaning cycle involving several stages and utilizing two or three different cleaning materials.

In the material to follow it is our intent to elaborate on the various methods of cleaning, with particular emphasis on the relationship between the material being cleaned and the method employed.



Where applicable, automatic cleaning equipment saves time and increases cleaning output. Here is a monorail equipped cleaning machine which combines washing, rinsing and drying in one unit. (Photo: Courtesy N. Ransohoff, Inc.)

Why Clean Metals

Any material on the surface of metal which is not intended to remain there as a permanent covering can be classified as dirt. Dirts may result from oxidizing, through protection given to prevent corrosion during storage, coolants used during machining, buffing compounds, drawing compounds, and soot and smut during heat treatment. In addition, there are chips, filings and plain ordinary dust encountered in commonplace handling.

Materials that must be removed include the above mentioned drawing and buffing compounds; oils and greases; alkalis and alkali salts; soluble salts of iron; soap; sulfated or sulfonated wetting or emulsifying agents; rust; heat scale; oxides; carbon; soldering and welding fluxes; and solid dirts.

When a part is to be used in its natural state, that is without further finishing, it will require only a simple cleaning which will take off the physical dirts. At times it is desirable that any oily film remain to inhibit corrosion.

If the part is to be given an organic finish, the problem is different. In this case any oxides or other matter which might chip or flake must be removed. Too, oils and greases must be cleaned off to permit adhesion of the finish to the metal.

Should electroplating be contemplated, it is essential that the metal surface be both physically and chemically clean. Any traces of oils, alkalis and other chemical films might impair the plating procedure and result in a faulty finish. To obtain chemically clean surfaces, two or more cleaning operations are often necessary.

Annealing and other heat treating operations require that surfaces be free of organic matter which could carbonize and result in faulty surfaces if not actually cause physical harm to the part.

Welding, particularly resistance welding, requires that surface oxides be removed in addition to other types of dirt. The oxide removal problem is particularly difficult with aluminum and magnesium, although all metal surfaces should be clean.

Although these are by no means all of the cases where cleaning is necessary, those listed will serve to typify the many reasons for cleaning metals.

Metal Cleaning Methods

There are five broad classifications of metal cleaning methods. Each type of cleaning has one or more variations or refinements to cover specific circumstances. The cleaning types are: solvent cleaning; emulsion cleaning; alkali cleaning; pickling and descaling; and, mechanical cleaning.

Alkaline Cleaning

The oldest, and by far the most prevalent, method of cleaning metals is by means of alkali compounds. At one time caustics were employed, but now most of the materials used are composites which are formulated to achieve several results. This method of cleaning proves satisfactory for the removal of all types of dirts, with the exception of insoluble compounds. In practically all cases where electroplating is required on steel, at least a final alkaline cleaning is essential.

Alkaline cleaning is considered the quality cleaning method and is generally used prior to electroplating to attain a chemically, as well as physically clean, surface. While alkaline cleaning can be used on most metals, it is not used extensively on aluminum, zinc, tin and brass. Strong alkaline cleaners tend to attack those materials and are difficult to control even in more mild solutions.

There are probably hundreds of proprietary alkaline cleaners. Basically, they are soluble alkaline silicates, phosphates, carbonates and hydroxides. Some include rosin, soaps and other emulsifying agents. Finally, many alkaline cleaners contain wetting agents which tend to reduce surface tension and speed up the cleaning process.

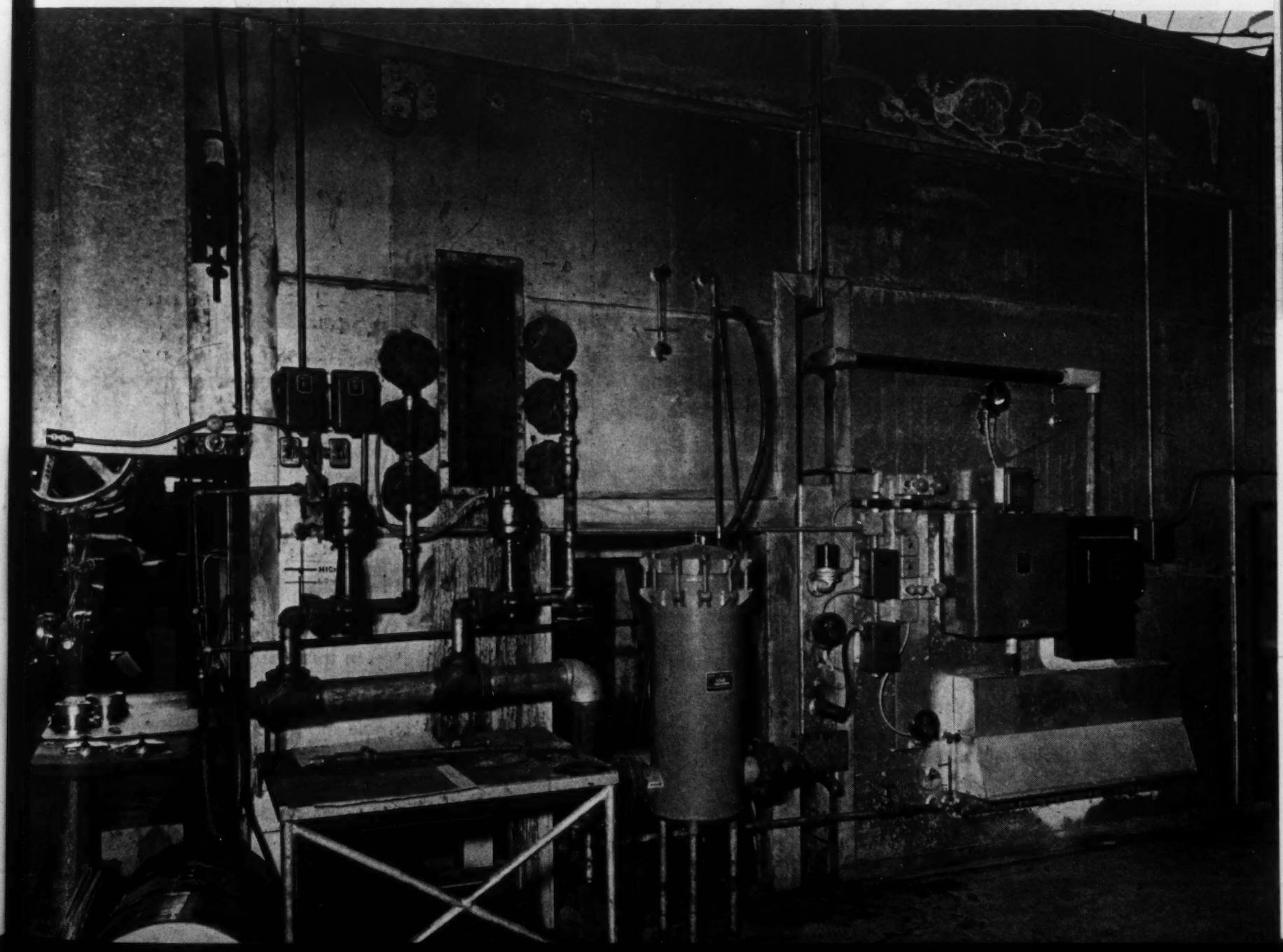
Alkaline cleaning is done by two methods, namely immersion and mechanical washing by means of sprays. Immersion cleaning is really a soaking process whereby the work to be cleaned is dipped into a tank of solution and permitted to remain sufficiently long to remove the dirt.

Mechanical washing is, of course, more expensive than immersion cleaning, due to equipment costs. However, where stubborn dirt is involved or high production is necessary, this method is most satisfactory. The sprays used in washing machines provide a combination chemical and mechanical action by directing the solution under pressure where it is most needed. The spray system can be adjusted to clean intricate parts and those having deep recesses.

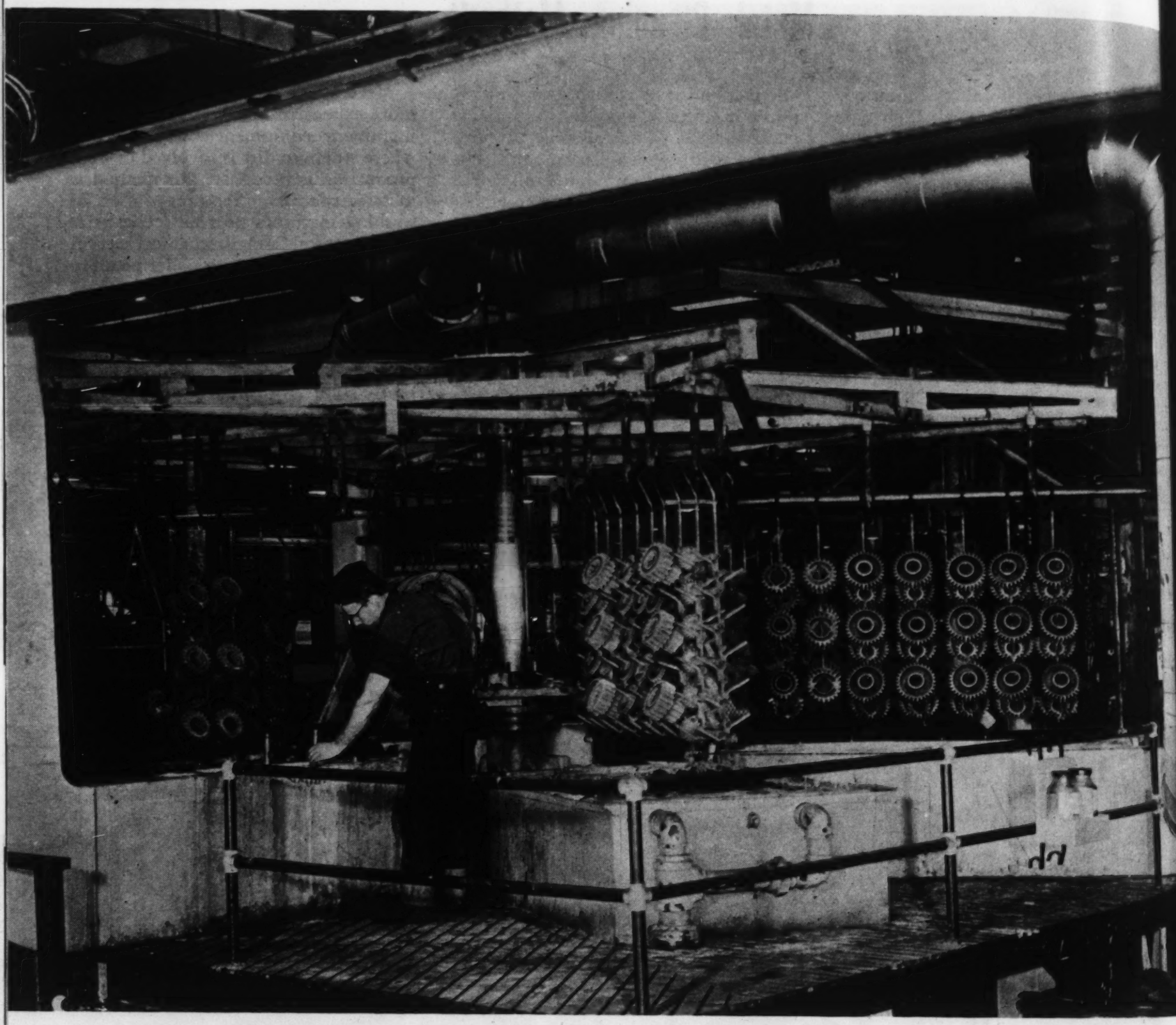
Generally speaking, alkaline cleaning is a low cost process. The cleaning compounds are comparatively inexpensive. The principal cost is in keeping the solution heated to the boiling point (212 F).

Although the cleaning compounds in use today are not as strong as the caustics once used, care should be taken in handling the solutions, since they can cause physical harm.

The rinse after alkaline cleaning is considered by some experts to be



Shown here is a special cleaning unit designed for aluminum ware degreasing. (Photo Courtesy Vapor Engineering Corp.)



Gears are being electrolytically descaled by the Bullard-Dunn automatic equipment at Caterpillar Tractor Co. (Photo: Courtesy Bullard-Dunn Process Div., The Bullard Co.)

equally important with the actual cleaning. After removal from the cleaning solutions, it is common for a thin alkali film to form on the metal parts. These residues must be removed, since they attack organic finishes. Frequently, multiple rinses are employed to make certain all traces of alkalis are removed. Included in the rinses are neutralizing baths which make use of dichromates or dilute chromic acid.

It is difficult, if not impossible, to make any specific recommendation in an article of this type as to exactly what alkaline cleaner to use. All conditions must be considered before any choice can be made, including the type and condition of dirt to be removed and the specific metal involved.

Electrolytic Cleaning

Electrolytic cleaning is a variation of immersion alkaline cleaning in which electricity is used to speed the cleaning action. It is frequently used prior to electroplating. In most cases the heavier deposits of dirt are removed by some preliminary cleaning step. Electrolytic cleaning results in a chemically clean surface.

In this method of cleaning, the alkaline cleaning solution serves as the electrolyte. The work serves as one pole and the tank, or specially provided steel plates, act as the other pole. Cur-

rent passing through the bath results in the emission of oxygen from the plus pole (anode) and hydrogen at the negative pole (cathode). Action of the gas breaks up the oil film holding dirt to the metal surface.

Parts to be cleaned can be made the cathode or the anode. When the work is the anode, the process is known as reverse current cleaning. However, the cleaning action is nearly double when the part serves as the cathode. Likewise, when nonferrous parts are cleaned they are used as cathodes. When anodic cleaning is used on the nonferrous metals, tarnishing and corrosion, in the form of oxide films, are likely to occur.

Special solutions are recommended for electrolytic cleaning. First, the bath should have high electrical conductivity. Also important, the cleaning material should contain no chlorides, which would attack the electrode, and no organic materials. Another important requisite is that it be nonfoaming.

Electrolytic cleaning is performed at voltages ranging from 6 to 12 v. and carrying 10 to 100 amp. Current density ranges between 20 and 60 amp. per sq. ft. Temperatures of cleaning solutions are not as high as in straight alkaline cleaning. For steel 190 F is satisfactory, while 160 to 180 F is used for brass and die castings.

Solvent Cleaning

Solvent cleaning is used in several ways, all primarily designed to remove oils and greases. Some solvent cleaning is done by soaking the part in a tank of solvent, some by spraying, but most involves a process known as vapor degreasing. Both use chlorinated solvents. Although highly efficient in the removal of oils and greases, degreasing does not provide the chemically clean surface essential for electroplating.

The principle of solvent degreasing is this: The hot, heavy vapor of the solvent forms the atmosphere inside the degreasing equipment. The metal objects to be cleaned are cooled and then passed into the vapor atmosphere. Upon striking the cool metal surfaces, the vapors condense into liquid solvent, which dissolves those oils and greases soluble in the solvent.

Vapor degreasing is often preceded by a spray or soak in solvent. In addition to removing some of the solid particle dirts through mechanical action, such precleaning lessens contamination of the solvent used in final cleaning. A final cleaning, if subsequent electroplating is planned, would probably involve alkaline cleaning.

Vapor degreasing is well suited to the cleaning of small parts of odd shapes where draining is a problem. Likewise, it is highly useful in cleaning nonferrous metals when water stains must be avoided.

Trichlorethylene and perchlorethylene are the solvents used in degreasing. Their cost is somewhat greater than the materials used for alkaline and emulsion cleaning. Considerable solvent loss occurs, primarily because it is difficult to confine vapors within the equipment. On the other hand, heating costs are less than for alkaline cleaning.

Perchlorethylene is less frequently used than trichlorethylene, but it has some advantages over the latter. It has a higher boiling point, therefore does not require that work be cold before entering the vapors. Also, since it is 1½ times the weight of trichlorethylene it is better for solvent spray cleaning.

The solvents used in this type of cleaning are toxic and therefore must be used under proper conditions so that dangerous concentrations do not result.

Emulsion Cleaning

One of the newer cleaning methods is the use of emulsifiable organic solvents. Cleaners of this type combine the action of a solvent and a soap. Two types of cleaners are employed. One is based on a hydrocarbon-soluble emulsifying material such as castor oil, triethanolamine oleate, acid sludge, or sulfonated corn oil added to a high flash point naphtha or kerosene. A second type blends potassium oleate with kerosene and a blending agent such as butyl alcohol or cresylic acid. Water can be used with either type of cleaner up to 10% as an aid to emulsifying action.

Emulsion cleaning is considered one of the least expensive methods of cleaning metals. The materials can be used on nearly any metal. They are suited to cleaning such metals as lead, aluminum and zinc, which are chemically active. In some respects it combines the better features of the two other principal cleaning methods.

Cleaners of this type are especially helpful in removing stubborn dirts, such as buffing compounds and pigmented drawing compounds which resist the action of alkaline cleaning and vapor degreasing.

Emulsion cleaning can be done by tank dipping or machine spraying. Regardless of the method, emulsifiable cleaners combine with oil dirts and can be rinsed off. Time required to effect a clean surface varies with the kind of dirt to be removed. The emulsifiable cleaners are used at room temperatures. After rinsing, a thin oily surface remains which prevents rusting. This film must be removed when electroplating is contemplated.

Parts to be cleaned by the emulsion method must be dry. Too, it is not considered a good method for parts with deep recesses or pockets or on groups of parts where locking or nesting might occur.

This method serves as an alternate to solvent cleaning in precleaning and for the alkaline cleaners where dirts which don't respond to alkaline cleaners must be removed.

Petroleum Spirit Cleaning

Another important type of metal cleaning is one which is intended to remove incidental processing dirts rather than to provide the surface for plating or other finishing operations. This method employs petroleum solvents. Solvents of this type wash off lightly adhering shop dirt, chips, dust and the like. Hand wipings is necessary to remove heavier dirts.

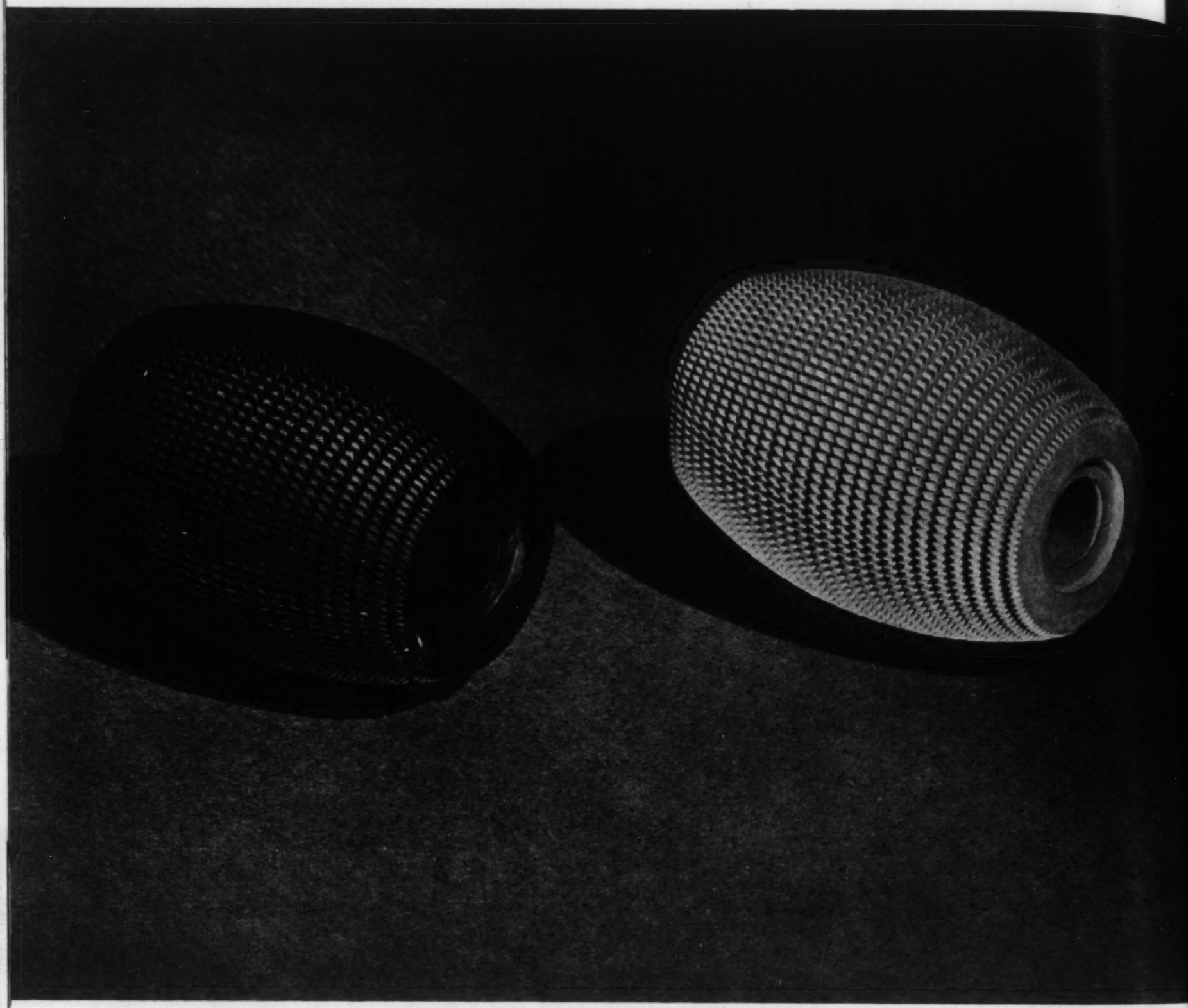
Petroleum spirit cleaning is useful in cleaning parts prior to or after assembly. Some delicate mechanisms or intricate assemblies might be damaged, rusted or stained by other cleaning methods. Therefore, the commonly used cleaning processes previously described could not be considered.

Parts or assemblies to be cleaned can be either dipped in or sprayed with the solvent and then dried by air blowers after draining.

Solvents used in this method of cleaning are highly volatile and must be used only under proper safety conditions.

Acid Pickling

The iron oxides which form on iron and steel surfaces as a result of hot working or through rusting have to be removed for any subsequent finishing. More satisfactory results in machining, grinding and heat treating also results when these oxides have been cleaned from the surfaces on which



Descaling of the 2496 teeth on these parts is performed electrolytically without change of dimension. The photograph shows a part before and after descaling. (Photo: Courtesy The Bullard Co.)

work is to be done. Acid pickling is the most common method of removing the unwanted oxides.

Parts which have been exposed for some time or which have been forged or heat treated are likely to require pickling. Likewise, thin oxide films which may remain after alkaline cleaning should be given similar treatment before electroplating, vitreous enameling and phosphate coating.

The majority of pickling is done in either of two acid baths—sulfuric acid or hydrochloric acid.

Sulfuric acid baths are 6 to 15% concentrations of this acid. It is used hot (140 to 175 F) and attacks the base metal in such a way that the scale loosens and falls off. Sulfuric is best suited to mild steels, and as the alloy content of the steel increases, temperature and concentration of the bath are lowered.

Hydrochloric acid in concentrations of 5 to 50% used at room temperatures. It is more costly and faster acting than sulfuric acid. This type of pickle is well suited to the cleaning of polished steel, as it acts rapidly on light oxide films. Many pickling solutions contain inhibitors which protect the base metal being cleaned. The inhibitors seemingly protect bare steel surfaces but permit action to continue on oxidized areas.

Pickling is likely to allow residues of inhibitors, acid and iron salts. To prevent pitting and rusting, the latter two materials are neutralized in an

Wire brushes are used to clean automotive clutches in this machine designed by Monmouth Products and Osborn Mfg. Co. The method cuts cleaning cost to below half of that required for hand cleaning.

alkaline rinse. Inhibitors are cleaned by regular alkaline cleaners.

Electrolytic Pickling

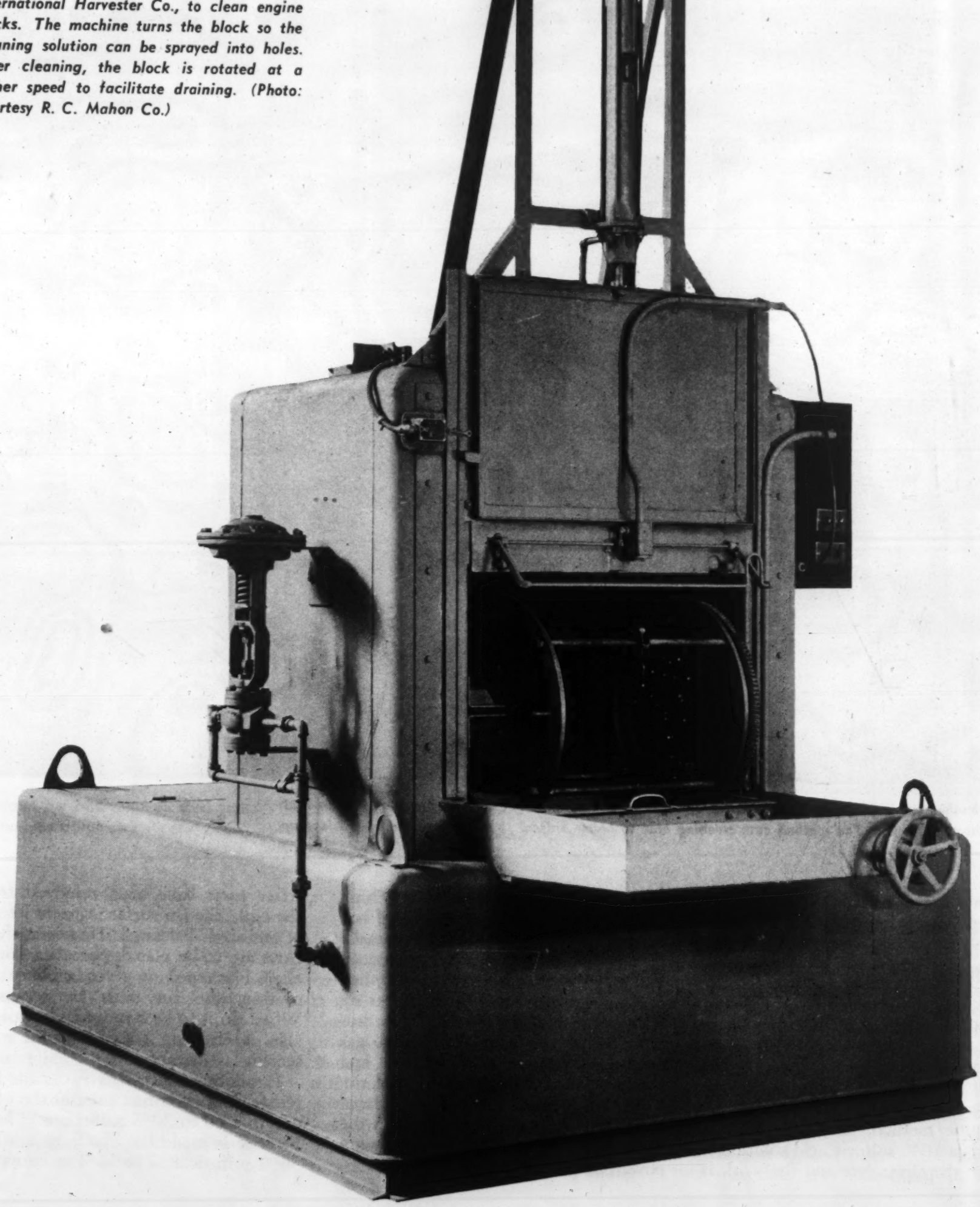
Recently there have been developed electrolytic methods of pickling. These processes are particularly useful in removing black magnetic iron oxide, which is difficult to remove in still pickling.

In one method, the Bullard-Dunn process, a 10% sulfuric acid solution is used as the electrolyte and the work is made the cathode. Anodes are high silicon iron, with the exception of one or two in each bath, which are made of tin. The bath is heated to between 140 and 150 F and electricity supplied at a current density of 60 amp. per sq. ft. at between 4 and 9 volts. The combination of the acid action and gas evolution removes scale or rust and recovers the area with a coating of tin.

The tin prevents the base metal from being attacked and its presence in the bath increases the bath's throwing power, making it act on inner recesses. After parts have been removed from the bath, the tin surface can be left on or removed as desired. However, if the parts are to be plated, porcelain enamelled, blackened or given a phosphate coating, the tin must be removed. When tin is to be removed, electrolytic alkaline cleaning is used with the work serving as the anode.

In another method, a two-stage system, the work is first used as the cathode in a 10 to 20% sulfuric acid bath. Next it is made the anode in a 40 to 50% sulfuric acid bath. The baths are

This specially designed machine is used by International Harvester Co., to clean engine blocks. The machine turns the block so the cleaning solution can be sprayed into holes. After cleaning, the block is rotated at a higher speed to facilitate draining. (Photo: Courtesy R. C. Mahon Co.)



perated at 90 F and current densities re 100 to 150 amp. per sq. ft. By this ethod parts are descaled in the first tage but retain an acid smut. The econd stage is provided to remove the mut.

Electrolytic cleaning is several times nore rapid for pickling than is still ickling. The electrolytic descaling rocess described was developed and s patented by the Bullard-Dunn Proc- ss Div. of The Bullard Co., Bridge- ort, Conn.

Mechanical Cleaning

In addition to the chemical cleaning methods previously described, there are several other cleaning processes which can be classed as mechanical cleaning. These methods are employed on their own merits for certain classes of work, but find greatest application in connection with certain tasks which cannot be performed by other types of cleaning.

Blast Cleaning—Metallic shot as well as sand or other mildly abrasive materials are used as the cleaning media in blast cleaning. The cleaning material is forced against the parts to be cleaned by air pressure or by being thrown and, in effect, knocks the dirt off the parts. In general, this method is employed in cleaning castings, forgings, heat treated parts, stampings and weldments. Blast cleaning can be used to remove scale, dirt, rust and small surface defects. Alkali cleaning is recommended after blast cleaning and before electroplating.

Tumbling—Small castings and forgings, weighing 10 lb. and less, are often cleaned by tumbling in rotating equipment. Cleaning is achieved through the action of metallic or abrasive stars, jacks, slugs or balls against the parts as they are tumbled about during rotating of the barrel. Some cleaning agents are used dry, while others are contained in a slurry. In addition to cleaning surfaces of sand, scale, rust and similar dirts, tumbling removes fins, burrs and sharp edges from the parts.

Wire Brushing—Small, easily handled parts can be cleaned by wire brushing. The brushes can be hand propelled or motorized. Scale, rust, oxide coatings and tool marks can be removed in this manner. Oxide coatings on such materials as magnesium can best be removed by wire brushing in preparation for welding or soldering.

Flame Cleaning—While not strictly a mechanical method, flame cleaning can be placed in that category. Flame cleaning is used primarily on large structural shapes made of ferrous materials. In this method, the surface to be cleaned is superficially heated with an acetylene burning torch. As the surface heats up, scale and rust flakes fall off, or can be easily knocked off.

Rinsing

While selection of the initial cleaning method is of utmost importance in preparing metal parts for subsequent finishing or use, the results of a good cleaning method can be negated by faulty or incomplete rinsing. Just as the choice of cleaning method is dictated by the soil to be removed and final finish of the part, so is the rinse determined by final requirements and previous cleaning.

When any one of various finishes are to be applied to the metal part which has been cleaned, it is important that all traces of alkalis, soluble iron salts, soaps, wetting agents, strong acids and oil film be removed. The usual practice is to neutralize alkalis by means of an acid dip and to offset acid's effect by alkaline rinse.

When parts are to be electroplated or enamelled, it is recommended that they be given an acid dip. However, between the alkaline cleaning and the acid dip a good rinse is necessary. This is demonstrated by the possible effect of the acid dip on a part which has been cleaned of saponifiable grease. If the soap formed during cleaning is not completely removed in a rinse, a grease will reform through action of the acid, making the entire cleaning cycle useless.

One type of acid dip, which is used prior to painting, consists of a solution of 0.01 to 0.1% phosphoric or chromic acid. The solution is kept hot so that it will dry rapidly on the metal surface. With this type of dip, the pH must be carefully controlled, keeping the pH between 3.0 and 5.0. This solution neutralizes contaminants and leaves surfaces passive.

When parts are to be plated, an ideal method of rinsing is through two stages. First a warm rinse is employed. This is followed by a cold rinse so the parts will remain covered with water when it enters the plating bath.

Not all surfaces should be given a complete rinse, however. For instance, steel parts that are to be stored or sent to inspection should not be thoroughly cleaned. It is likely that as the part is removed from the cleaning bath a slight oil film will remain on its surfaces. This film should not be removed since it will serve to protect the part from rusting.

A good means of testing for a clean surface is the water break test. Water will not adhere to oily surfaces, so if the entire surface of the parts will retain water it is safe to assume that the surface is clean.

Cleaning of Specific Metals

While some metals can be cleaned by practically all of the commercially used methods, extreme care must be used in cleaning other metals. Caution is needed, particularly in cleaning such surface active metals as aluminum, magnesium, zinc, copper and brass. Some cleaners do not attack those metals, but also they do not provide the chemically clean surfaces required for certain finishing operations. In the section to follow, recommendations will be made for certain of the more difficult to clean metals.

Aluminum

Aluminum is sensitive to both acid and alkali type cleaners. Aluminum die casting alloys are particularly susceptible to attack by alkali cleaners. However, to paint, electroplate, anodize or spot weld aluminum, clean surfaces are necessary. Cleanliness includes the removal of the natural oxides which form on aluminum.

Hand Cleaning—While hand cleaning by means of various solvent solutions can be used on aluminum, this method is not too satisfactory. In many cases the dirt film is merely spread

around rather than removed if cleaning is carelessly done.

Solvent Dip Cleaning—Dip tank cleaning of aluminum in a solvent is not too effective, since the oils and greases soon contaminate the solvent. Oil and grease globules which remain suspended in the solvent tend to adhere to the work.

Acid Cleaning—Certain types of acid cleaning solutions are used to provide a good, clean surface on which paint will adhere. One widely used solution is of the phosphoric type. The solution is made up as follows: 10% of 85% phosphoric acid, 40% butyl alcohol, 30% isopropyl alcohol with the remainder composed of a small amount of a wetting agent and water. This solution will remove light oxide films, etch the metal slightly, and leave a thin, inert aluminum phosphate film.

Alkaline Cleaning—Although alkalis tend to attack aluminum surfaces, mild inhibited cleaners of this type can be used. Most commonly used are special compounds used at a ratio of 4 to 6 oz. of cleaner per gal. of water. Such solutions are used at a temperature of 160 to 180 F and will remove light grease, oil films and dirts in 3 to 5 min. Many producers of cleaning compounds have specially developed materials for use of aluminum.

Vapor Degreasing—Vapor degreasing is used successfully to clean grease and oil from aluminum. Hot stabilized trichlorethylene or tetrachorethylene is used to best advantage in a series of three tanks. Parts to be cleaned are immersed in the solvent in the first tank, where the heavy dirts are removed. In the second tank the parts are drained and rinsed. In the final stage vaporized solvent condenses on the work and washes off the remaining greases and oils. Care must be used when trichlorethylene is employed as the solvent, since aluminum particles remaining in the bath may cause the solvent to hydrolize and form hydrochloric acid. The acid, of course, will attack both aluminum parts and cleaning tanks.

Blast Cleaning—Cleaning by mechanical action has long been employed in preparing aluminum for further finishing, particularly painting. Shot and sand blasting are widely used for cleaning aluminum castings. This type of cleaning likewise is used after heat treating to remove heat scale.

Cleaning Aluminum for Spot Welding—One of the most important cleaning problems on aluminum is in preparing the material for spot welding. All dirts and oxides must be removed to permit an even flow of electrical current and thus attain even heating and uniform welds throughout the area being joined. Parts are first cleaned by alkali cleaning to remove oils and greases. Oxides are then removed by mechanical brushing or by phosphoric-chromic acid solutions. (One solution is composed of 9 oz. by weight of phosphoric acid; 2¾ oz. by weight of chromic acid, plus water to make one gallon.) Other acid immersion cleaners can be used upon specific recommendation.

Magnesium

Four cleaning methods are satisfactorily used on magnesium alloys, namely, solvent cleaning, alkaline cleaning, acid pickling and mechanical cleaning.

Solvent Cleaning—Chlorinated solvents, petroleum spirits, alcohol, lacquer thinners and the emulsion cleaners can be used on magnesium without harmful effect. Solvent cleaners are used to remove oily matter prior to alkaline cleaning or as a precleaning operation before painting.

Alkaline Cleaning—Alkaline cleaning is the most suitable cleaning method for magnesium alloys. Its value lies in the fact that it removes oils and other dirts and at the same time cleans chemical treatments applied to protect the magnesium during storage and fabrication. Alkaline cleaners of the stronger type (pH above 11) should be used for best results. Electrolytic cleaning can be employed using a bath which is equally suited to soak cleaning. The bath is composed of trisodium phosphate (4 oz.), sodium carbonate (4 oz.), soap or wetting agent (1 oz.), and water to make 1 gal.

The solution should be operated at 180 to 212 F for soak cleaning and 160 to 180 F for electrolytic. Agitation of the bath is necessary. Gas evolution in electrolytic cleaning and boiling when operated at 212 F have an agitating effect, but at lower temperatures in immersion baths agitation must be provided.

In electrolytic cleaning the work is made the cathode, and direct current of 10 to 20 amp. per sq. ft. of cathode area is applied for 1 to 3 min.

As with other materials, a complete rinse after alkaline cleaning is necessary with magnesium. Alkali drag out would contaminate baths for chemical treatment, which follow the cleaning.

Acid Cleaning—Layers of oxide some chemical coatings, burned-o forming lubricants and other matt which will not respond to alkali solvent cleaners is removed by a sol tion of chromic acid. A solution 1.5 lb. of chromic acid plus water make 1 gal. will not attack magnesiu but will dissolve oxides and hydroxid which are usually present. If graphit base lubricants are present, calcium magnesium nitrate is added to t chromic acid solution in the ratio 4 oz. per gal.

Parts to be cleaned are immersed the solution operating at 190 to 212 for 1 to 15 min. pH of the bath is mai tained between 0.5 and 2.0.

A sufficiently long pickle to remov at least 0.002 in. of surface should fo low sand or shot blasting. For this pu pose a pickle consisting of 3 parts concentrated sulfuric acid and 97 par of water is used. The required amou of metal will be removed by immersio for 10 to 15 min. at room temperatur Pickling should be done before m chining, since the metal removal ma affect tolerances.

Mechanical Cleaning—Heavy dirt oxides, casting skin and the like ca be removed from magnesium parts b wire brushing; sanding; sand, grit an shot blasting. Although the blastin procedures are economical and effi cient, they are not recommended wher maximum corrosion resistance is de sired. The sulfuric pickle should alway follow any blast cleaning.

Ferrous Metals

Practically all of the cleaning meth ods described in an earlier section o this manual can be used on the entire group of ferrous metals. However, some precautions are necessary in ap plying certain cleaning methods t certain ferrous metals. Some of those precautions will be pointed out here.

Cast Irons—The cast irons can be cleaned by all of the methods in com mon use, including electrolytic descal ing. Vapor degreasing is effective, bu parts should be protected against rust ing after such cleaning. Blast cleaning is one of the most satisfactory methods of cleaning cast iron parts, particularly since by this means sand and other sur face dirts are quickly removed. Small cast iron parts are cleaned readily by tumbling.

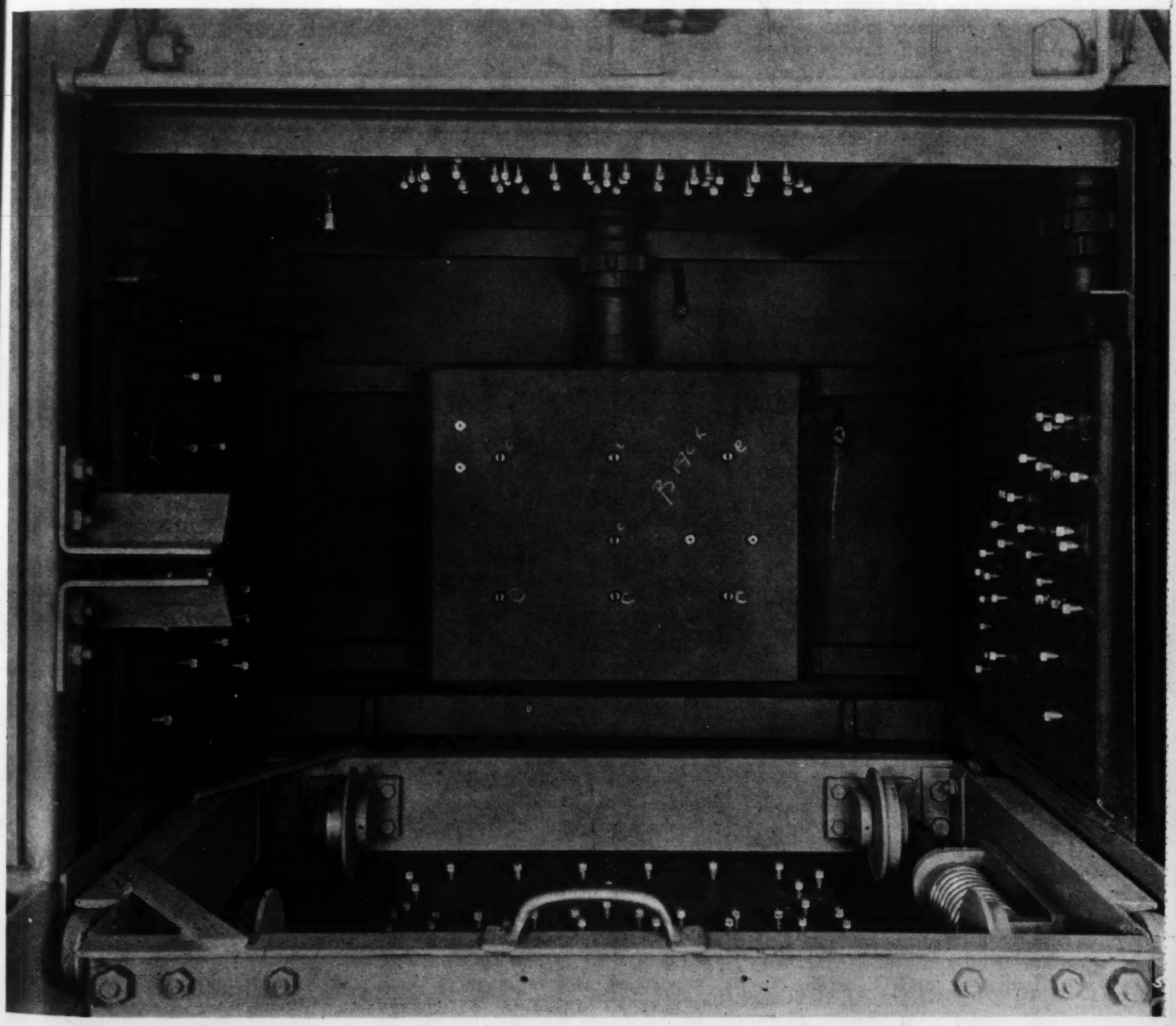
Carbon Steel—Still tank alkaline cleaning is highly effective on carbon

steels, particularly when chemically clean surfaces are required. With most steels, if any further finishing is contemplated, alkaline cleaning is provided at least once during the cleaning cycle. Carbon steels can be cleaned by electrolytic methods, although it is best to clean them anodically. The latter is particularly true of the high carbon steels and for parts that are highly stressed. Cathodic cleaning can lead to hydrogen embrittlement. Electrolytic cleaning is done in a bath containing 8 to 12 oz. of alkali compound per gal. of water and at a bath temperature of between 150 and 180 F. As with other ferrous metals, vapor degreasing will permit rapid rusting of the steel surfaces unless the parts are quickly processed or other wise protected.

Alloy Steels—The same general rules applying to carbon steels hold true in the cleaning of alloy steels, with the exception of tool steels and stainless steel.

Tool and Die Steels—Blast cleaning and tumbling can be used on these steels, but is not used too frequently since most such steels are finished to extremely close tolerances. These methods cannot be controlled closely enough to retain such tolerances. Alkali cleaning of this type of steel should be followed by passivating treatments to prevent staining. Likewise, electrolytically cleaned parts should be plated or coated with a rust preventative immediately after the cleaning. Solvent cleaning is most satisfactory for tool steel parts because of the light film of oil which remains on the surface. Of course, if plating is contemplated, the residual

The high pressure spray jets in this automatic cleaning machine are so placed as to assure delivery of the cleaning solution to all interior as well as exterior parts of the engine block being cleaned. (Photo: Courtesy R. C. Mahon Co.)



film would have to be removed by means of alkali cleaning.

Stainless Steel—The cleaning of stainless steel is primarily for the purpose of attaining a physically clean surface, since finishes are seldom used on this type of steel. Alkali cleaning can and is used frequently. With alkali cleaning the rinse is important. Likewise, prompt drying is essential. Forced dry air or hand wiping are used. Many parts, particularly large parts, made of stainless steel are cleaned by solvent wiping. This method of cleaning leaves a film of oil which is subsequently removed by dusting with precipitated calcium carbonate and polishing.

Blast cleaning is used most frequently on semi-finished parts. After blast cleaning, the parts should be given a passivating treatment to remove any iron particles which have attached themselves to the stainless steel surface. If the parts are to be ground and polished, passivating is not necessary, since the grinding will remove any iron particles which might lead to corrosion. Passivating is accomplished by immersing parts in nitric acid solutions. The strength of nitric acid baths varies with the alloy content of the steel. Tumbling is used both to clean surfaces and to provide a burnished finish on stainless.

Copper and Copper Alloys

Blast Cleaning—Bronze is readily cleaned by blast methods since it is hard enough to stand up under force of the blast media. Copper and brass can be cleaned by this method, but since they are relatively soft, blast cleaning should not be used except with extreme caution.

Alkali Cleaning—Copper itself is not attacked by alkali cleaners, so it can be cleaned by this method. However, brasses and bronzes are attacked by alkalis. Electrolytic cleaning of these metals is possible. Since alkalis tend to tarnish copper, parts should be kept well below the surface of the solution. Silicate inhibited alkali cleaners work well in electrolytically cleaning brass and bronze with the parts serving as either the cathode or anode. Current densities of 50 amp. per sq. ft. are employed with the bath heated to between 160 and 180 F.

Solvent and Vapor Cleaning—Where the parts are to be cleaned of coatings of oil and grease, either solvent cleaning or vapor degreasing can be used with excellent results.

Other Metals

Zinc—Most of the commonly used cleaning methods can be used on zinc and zinc alloys. However, several of the methods require special compounds to insure satisfactory cleaning without damage to the metal surface. Strong alkali solutions tend to corrode and discolor zinc. This is particularly true of the die casting alloys. Silicate type alkali cleaners are used satisfactorily if care is taken to maintain pH of the bath under 12. Likewise, special alkali compounds are required for electrolytic cleaning. Solvent cleaning and vapor degreasing can be used safely in cleaning parts made of any of the commercial zinc alloys.

Lead-Base Materials—The mechanical methods of cleaning are excluded from materials suitable for cleaning lead-base metals because of their softness. Neither alkaline or electrolytic cleaning are too satisfactory, primarily because of the adverse effect of alkali on lead. In addition, electrolytic cleaning is likely to cause pitting due to lead being dissolved into solution. This leaves emulsion cleaning, solvent cleaning and vapor degreasing as the most satisfactory method of cleaning the surfaces of lead parts.

Tin-Base Materials and Babbitt—Alkalis tend to attack these materials and, therefore, should be avoided. Electrolytic cleaning is sometimes used in alkaline solutions with silicate inhibitors, but there is danger of the bath becoming loaded with tin and the tin depositing on parts. As with the lead alloys, emulsion and solvent cleaning and vapor degreasing prove most satisfactory for these metals.

Conclusion

It would require a ponderous tome to present the full story of metal cleaning with anywhere near the thoroughness the subject merits. Therefore, the material presented here has been distilled to give the essence of the subject.

There are many manufacturers devoted to the development and application of cleaning compounds. In the course of their experience they have compounded many variations of cleaning materials to take into account the varied requirements of specific industries. Most of the compound producers maintain technical staffs willing to and capable of helping any manufacturer select and apply cleaning materials to achieve necessary results at the lowest cost.

Nothing has been said here about the equipment for metal cleaning operations. The type of equipment depends upon the cleaning method used, the material being cleaned, the dirt to be removed, and production requirements. Here, too, the advice and counsel of the cleaning material manufacturer should be sought, since in most cases his formulations are compounded for use in specific types of equipment.

Acknowledgment

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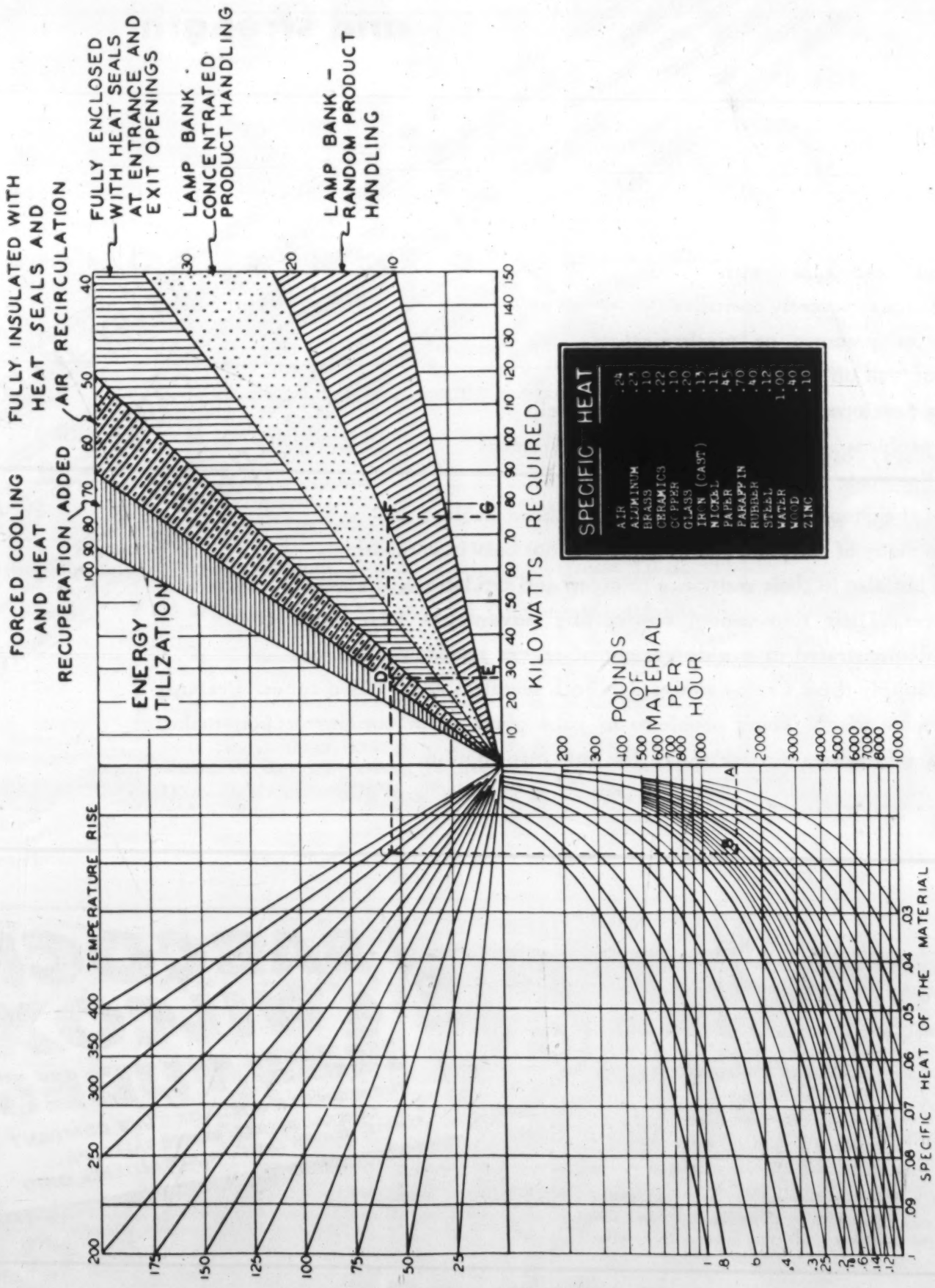
November, 1948

METHODS: Heating

Power Requirements for Heating Materials by Infra-Red

This chart may be used to obtain a general indication of electric power required for heating materials in the range up to 400 F by infra-red under various oven conditions and design. An example of how the chart is used is given by the dotted lines. In this case 1500 lb. per hr. (A on the chart) of steel whose specific heat is 0.12 (B) are to be heated to 300 F (C). If the oven is fully insulated with heat seals and has air recirculation (D), the energy utilization would be about 28 kw. (E). If a lamp bank is used with random product handling, about 75 kw. (G) would be required.



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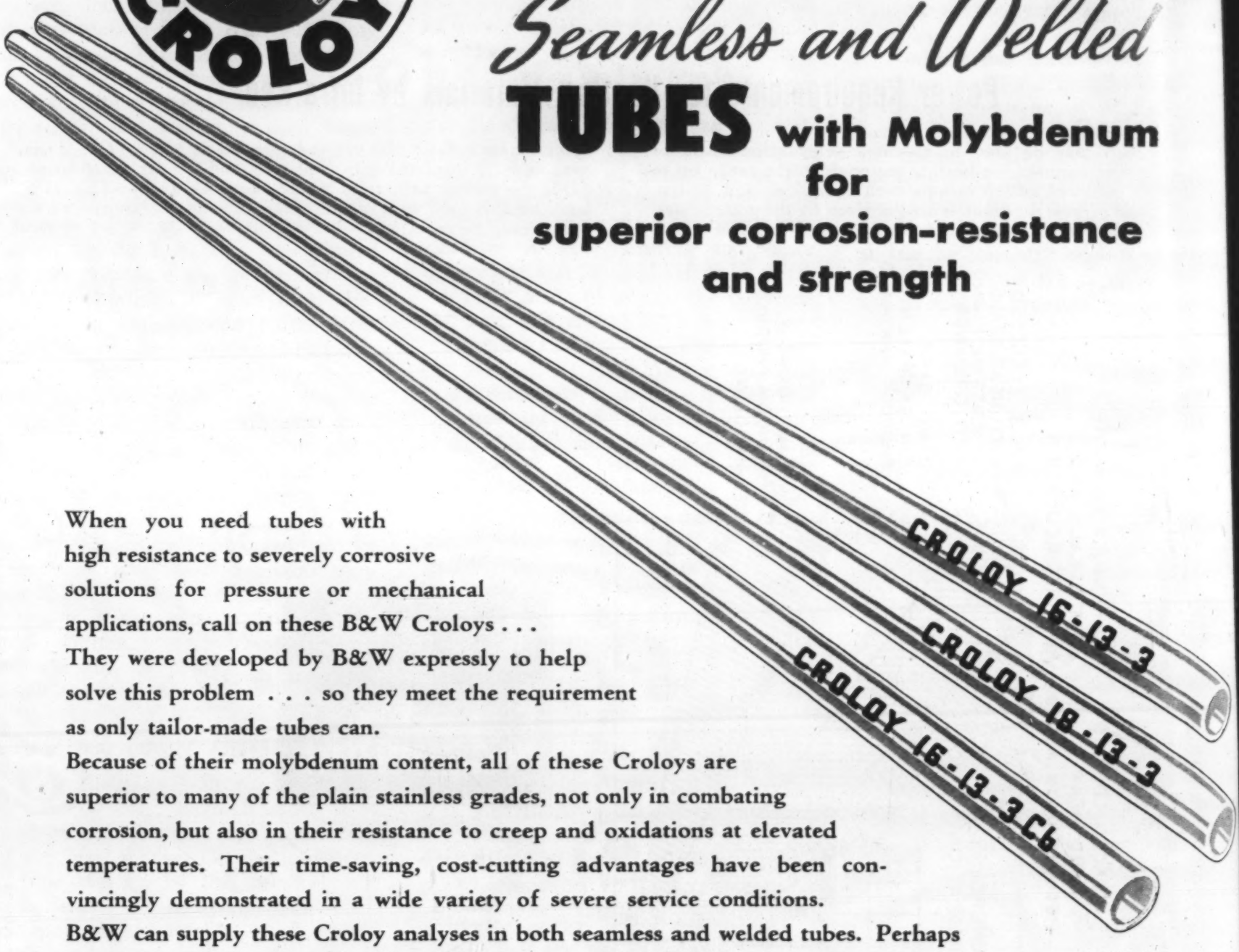

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November, 1948

MATERIALS: General

Maximum Temperature of Stability of Various Alloys to Oxidizing Atmospheres

Material	Composition	Stable to C in Air
Copper		450 (842 F)
Iron		500 (932 F)
Brass	70 copper, 30% zinc	700 (1292 F)
Nickel		800 (1472 F)
Chromium		900 (1652 F)
Iron-Chromium Alloys	4 to 6 chromium, 0.1 to 0.2 carbon, 0.5 manganese, 0.5% silicon, rest iron	650 (1202 F)
	8 to 10 chromium, 0.15 carbon max., 0.5 manganese, 0.5% silicon, rest iron	750 (1382 F)
	12 to 14 chromium, 0.10 carbon max., 0.5 manganese, 0.5% silicon, rest iron	750/800 (1382 to 1472 F)
	16 to 18 chromium, 0.10 carbon, 0.5 manganese, 0.5% silicon, rest iron	850/900 (1562 to 1652 F)
	25 to 30 chromium, 0.10 carbon, 0.5 manganese, 0.5% silicon, rest iron	1050/1100 (1922 to 2012 F)
Iron-Chromium	17 to 19 chromium, 8 to 10 nickel, 0.5 manganese, 0.5 silicon, 0.1% carbon, rest iron	850/900 (1562 to 1652 F)
Nickel Alloys	17 to 19 chromium, 25 to 26 nickel, 0.5 manganese, 3.0 silicon max., 0.2% carbon max., rest iron	1050/1100 (1922 to 2012 F)
	22 to 28 chromium, 12 to 16 nickel, 0.5 manganese, 0.5 silicon, 0.15% carbon max., rest iron	1000 (1832 F)
	24 to 26 chromium, 19 to 21 nickel, 0.75 manganese, 1.0 silicon, 0.15% carbon max., rest iron	1050/1100 (1922 to 2012 F)
	15 to 20 chromium, 30 to 35 nickel, 0.5 to 1.0 manganese, 1 to 2 silicon, 0.15% carbon max., rest iron	1050/1100 (1922 to 2012 F)
	14 to 18 chromium, 60 to 65 nickel, 1 to 2 manganese, 1.5 to 2 silicon, 0.1 to 0.5% carbon, rest iron	1000/1100 (1832 to 2012 F)
	12 to 20 chromium, 70 to 80 nickel, 2 manganese, 2 silicon, 0.15% carbon, rest iron	1100/1150 (2012 to 2102 F)
Chromium-Nickel Alloy	19 to 20 chromium, 77 to 79 nickel, 2.5 manganese, 0.5 silicon, 0.25% carbon max., rest iron	1150 (2102 F)
Chromium-Aluminum	5 to 6.5 chromium, 0.6 to 0.8 aluminum, 0.45 manganese, 0.5 silicon, 0.10% carbon, rest iron	800 (1472 F)
Iron Alloys	6.5 to 8.5 chromium, 1.2 to 2.0 aluminum, 0.45 manganese, 1.0 silicon, 0.10% carbon, rest iron	900 (1652 F)
	12 to 15 chromium, 2.5 to 3.5 aluminum, 0.5 manganese, 0.5 to 1.0 silicon, 0.12% carbon, rest iron	900/1000 (1652 to 1832 F)
	18 to 20 chromium, 3 to 4 aluminum, 0.5 manganese, 0.5 to 1.0 silicon, 0.12% carbon, rest iron	1200 (2192 F)
	20 to 22 chromium, 3 to 5 aluminum, 0.5 to 1.5 manganese, 0.5 silicon, 0.10% carbon, rest iron	1250/1300 (2282 to 2372 F)
	20 chromium, 5 aluminum, 1.5 to 3.0% cobalt, rest iron	1150/1300 (2102 to 2372 F)
	30 chromium, 5 aluminum, 0.5 manganese, 0.5 silicon, 0.1% carbon, rest iron	about 1330 (2458 F, app.)

Prepared by Benjamin Lustman, Metallurgical Section, Research Laboratories, Westinghouse Electric Corp.

JEWELRY FIRM MAKES LOCK FOR BRIEFCASE

Above: Rexlock for Rexbilt Case, and its parts. Made by the jewelry firm of Augat Bros., Inc., Attleboro, Mass. Many parts of Revere brass.

Rexbilt Briefcase, made by Rexbilt Leather Goods Corp., 151 West 26th St., New York 1, N. Y.

THIS is the story of a briefcase. It has some unusual angles that will be entirely unsuspected by the men who happily tote the case. They would never guess it, but the interesting and quite new combination lock was made by Augat Bros., Inc., Attleboro, Mass. The Augats are manufacturing jewelers, long-time customers of Revere. If those who buy the Rexbilt briefcase think the lock is a jewel, they will be quite right.

Perhaps the Rexbilt Leather Goods Corporation, New York City, really did not have to go to a jewelry maker to have the new Rexlock made with the necessary precision. But you know how people are when they want to offer a really fine product. Fussy. That protects quality. Anyhow, Augat Bros. and Rexbilt are very happy, and so is Revere, for Revere brass is largely used in the lock wherever beauty, reliability and corrosion resistance are important. Some die castings and sheet steels are also used. This, then, is another good example of the wise choice of the proper materials to meet operating conditions, assuring prolonged service and enduring satisfaction to the user. Incidentally, not only is solid brass used liberally in the lock itself, but the handle posts are of the same enduring metal. Thus you have a combination of good metals, good leathers, a good lock idea, to make a quality briefcase . . . . Revere is always glad to collaborate with manufacturers seeking good metals, and welcomes the opportunity to study both new and old applications.

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MATERIALS & METHODS

DIGEST

A selective condensation of articles—presenting new developments and ideas in materials and their processing—from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

New Data on the Modulus of Elasticity of Metals

The modulus of elasticity is of interest both for practical and theoretical reasons. Practically, the importance of the modulus is shown by its use in many design formulas. Theoretically, the modulus is closely related to the lattice structure and, in alloys, to the atom distribution within the lattice.

A comprehensive picture of the available data on the modulus is given in a series of recent articles in *Zeitschrift für Metallkunde* (German). In the Jan. 1948 issue, W. Köster presents data on the modulus of 32 pure metals as affected by temperatures from −290 F to about 1830 F, or to the melting point. He also examines an irregularity in this relationship found with copper, silver, aluminum and magnesium. The unexpected decrease in the modulus and increase in the damping capacity in certain temperature ranges appears to be a function of the purity of the metals because it is eliminated in copper and silver by the addition of deoxidizers. In the Apr. issue, W. Köster and W. Rauscher cover the change in modulus with the composition of a large number of binary alloys.

Finally, in the May issue, W. Köster summarizes the available information on the modulus, with particular attention to its relationship to other physical constants. The modulus of elasticity of metals changes periodically with the atomic number. It is definitely a directional property but is little affected by microstructure. Attempts to relate the modulus to the atomic volume and the melting temperature are unsatisfactory. The modulus decreases approximately linearly with temperature.

The temperature-modulus curves of a number of pure metals coincide when the modulus is taken as a function of its value at absolute zero and the temperature as a function of the melting temperature. The temperature coefficient also changes periodically with the atomic number. Polymorphous changes are accompanied by sudden changes in the modulus. The ferromagnetic condition increases the modulus considerably. The formation of an ordered structure in alloys likewise increases the modulus. In heterogeneous alloy systems, the modulus is proportional to the composition. In continuous solid solutions of low affinity, the modulus generally changes according to composition. In limited solid solution series, the modulus usually decreases. The modulus of intermetallic phases is mainly determined by the type of compound and their crystalline structure. With suitable consideration of these factors, it is possible to predict roughly the modulus of given compounds.

Reports on Welding Progress

At the annual meeting of the *American Welding Society* in Philadelphia, Oct. 25 to 29, interesting papers were presented covering a variety of subjects. Taken together, they provide a good review of current progress in welding of metals. Digested here are those which will be of most interest to materials engineers.

Inert-Gas-Shielded Welding

Among the outstanding developments in this type of welding announced during the past year is inert-gas-shielded spot welding. A paper by F. J. Pilia, "Inert-Gas-Shielded Spot Welding," described the new welding process which combines some of the features of resistance spot welds and metal arc plug welding. This fusion spot-welding process can be used on ferrous materials where the surfaces are free from heavy oxide and on some nonferrous materials with additional preparation. The method is used to its greatest advantage where the work is obstructed and both sides of the weld cannot be reached, or where the size and shape of the workpiece require resistance welding-guns or machines with excessive throat depth.

Installation cost is low, so that inert gas shielded spot welding may be employed where economics or such factors as size of production would not justify investment in the more expensive resistance spot welder. It is also of advantage in that the manual skill of metal arc or gas weld tacking can be replaced on light sections in production by non-skilled operators. This process does not replace resistance spot welding on a cost per spot or time basis when conditions are favorable to resistance spot welding.

Although copper has long been considered one of the best metals for applications where corrosion and high heat transfer are the controlling factors, its use has been limited by the fact that it is one of the hardest to weld metals. A paper by J. W. Mortimer, "Welding Pure Copper for Pressure Vessels," proposes not only a solution to this problem, but also describes a related series of experiments with inert-gas-shielded welding, carried out under shop conditions, showing that copper can be welded to meet pressure vessel requirements.

Another specific use of inert-gas-shielded welding was described by F. L. Plummer, in his paper on fabricating storage tanks using a combination of steel and aluminum, "Field Erected Storage Tanks of Aluminum." The particular tanks involved are used for storage of crude oils having high sulfur content. With all-steel tanks the roofs and roof supports corroded rapidly; therefore, aluminum was adopted for these parts. It was necessary to prevent galvanic action at contact surfaces between steel and aluminum. Also provision has to be made for different coefficients of expansion during erection. The use of an inert-gas-shielded tungsten electrode arc permitted the use of lap joints welded without flux.

The practical aspects and applications of inert-gas-welding of stainless steel were covered in a paper by N. A. Blickman, "Production Heli-Welding Stainless Steel". Various examples and set-ups used, as well as the pros and cons of manual, semi-automatic and full automatic methods, were discussed. An important factor in successful welding of stainless steel is the jigging technique, and careful attention must be paid to proper fixtures and avoiding poor fit-up. In addition to describing the various

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DIGEST

welding techniques, the paper touched on the finishing of stainless steel in relation to inert gas welding.

Inert-gas-shielded arc welding processes can be applied with many sources of welding power. H. A. Huff and A. N. Kugler in their paper, "Practical Aspects of the Inert-Gas-Shielded Arc Welding Process," analyzed the various power sources and evaluated the relative advantages and disadvantages of each method in relation to the welding of a number of different metals. Thus, the relative weldabilities by different methods as well as recommendations for specific applications were presented. And finally, causes and corrections for the more commonly encountered types of difficulties were discussed.

Welded Ships

The current interest in design and welding of ships extends beyond the welding field, for the problem encountered here is present throughout the metal industries. It is the problem of the inter-relationship of materials, design and processing. A number of important papers were presented at several of the sessions devoted to this subject.

One of the papers, "New Factors To Be Considered in the Design and Welding of Ships," by M. Forman, carefully evaluated the most recent research and service records of hatch corners in terms of the relative importance of design and the factor affecting the notch toughness of steel. The act of welding tends to impair the notch toughness of the structure, so various methods have been developed to improve the welded plate. Some of these are preheating, postheating, electrodes and welding procedures.

The development of weldable high strength steels was the subject of a paper by C. E. Sims and H. M. Banta, "The Development of Weldable High Strength Steels". The opinion was expressed that as far as the parent metal is concerned, freedom from underbead cracking is the important attribute of a weldable steel. It was found that carbon and manganese, while good strengtheners, are potent in promoting cracks. Silicon and chromium did not increase yield strength or cracking very much. Vanadium and molybdenum gave pronounced increases in yield strength without increasing the tendency to cracking, while aluminum in small additions promoted underbead cracking.

High Temperature Alloys

Where severe service conditions are encountered much can be learned about the metals by studying those that failed in service. M. E. Holmberg's paper, "Use of Alloys and Welding in High Temperature Service in Oil and Gas Processing," was based on the study of failures in welded

DIGEST

alloy structures used in the oil industry. From his studies, he found that where corrosion is not an important consideration, stabilized material is not required even though 18:8 is welded and exposed in service to temperatures within the carbide precipitation range of 800 to 1500 F.

Ferritic materials, such as 5% chromium-molybdenum, 12% chromium-molybdenum, 12% chromium, etc., cannot always be successfully welded with austenitic rods. Where such welds are subjected to many great changes in temperature, due either to frequent shut-down or cyclic operations, cracks develop as a result of the differences in the coefficients of expansion of the austenitic and ferritic materials, and in some cases, because of the differences in thermal conductivity.

Powder-Cutting of Stainless Steels

With the widespread application of the powder-cutting process for cutting stainless steels, there has been great interest in the effects of the process on the corrosion resistance of the steels, and whether the effects can be corrected by suitable annealing or modifications of the cutting procedure. C. R. Bishop and L. E. Stark investigated these problems. Their paper, "Corrosion Resistance of Powder-Cut Stainless Steels," discusses the condition of the kerf and heat-affected zones of powder-cut edges in stainless steels, the welding of the powder-cut beveled edges, and the minimizing of heat effects by means of water-quenching applied simultaneously with the cutting operation.

Tests were performed to compare the effects of powder-cutting on a variety of unstabilized and stabilized types of stainless steels. The results were based on corrosion studies and metallographic examinations of powder-cut specimens. The zone adjacent to the cut face, which is chemically altered by the powder-cutting process, is not more than 0.03 in. thick, and this zone can be removed by superficial grinding. Preparation of beveled plate of unstabilized stainless steels by powder-cutting does not increase the severity of the heat-affected zone when subsequently welded by manual arc or submerged melt methods.

Selecting the Proper Quenching Oil

Although the quenching speed is an important factor, it is not the sole consideration in the selection of a quenching oil, according to G. T. Dunkley in the Summer 1948 issue of *Metal Treatment* (British). Oils are usually specified by certain physical

Where electrical contact is required to a moving part, laminated precious metal rings offer unusual operating characteristics at a real saving in cost over solid precious metal rings.

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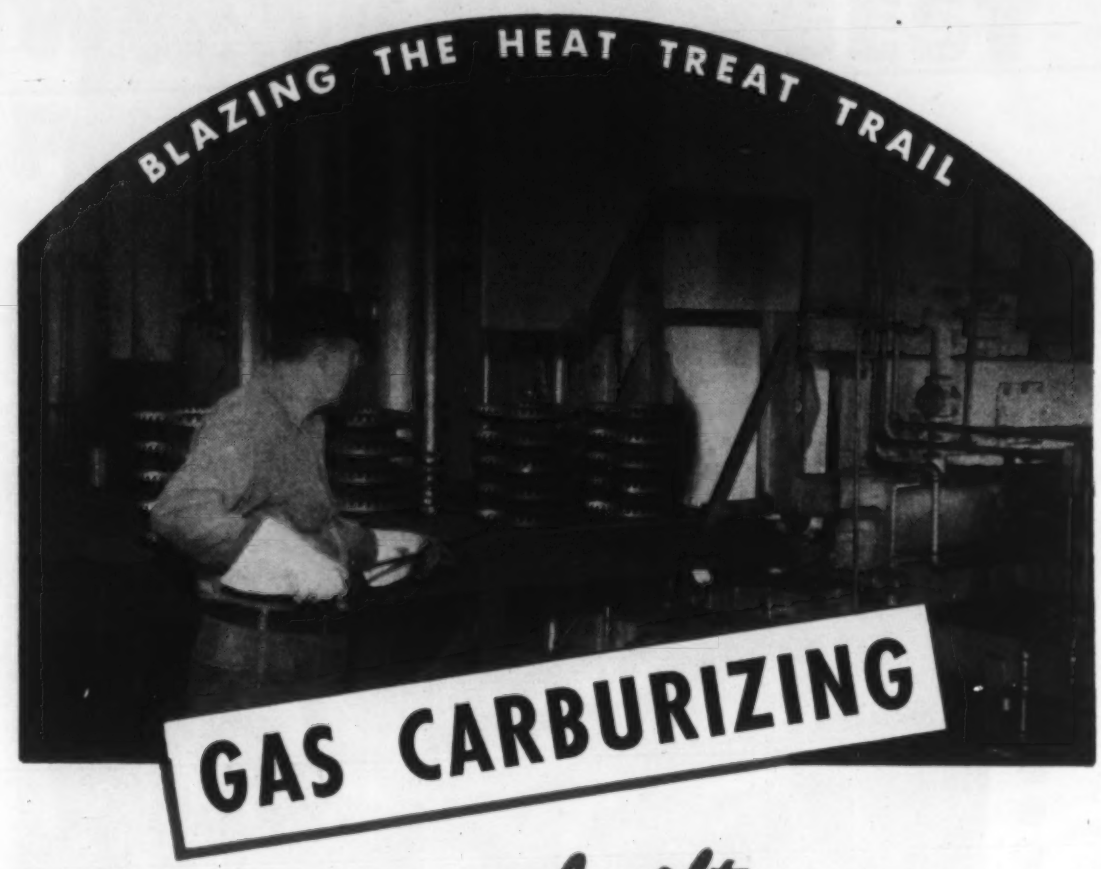

Developed by Holcroft in 1935 for

MORE ACCURATE, LOWER-COST CASE HARDENING

HOLCROFT engineers established the basic principle on which *all* modern gas carburizing furnaces operate—namely, that in order to control the process, a non-decarburizing gas must be used to dilute the hydrocarbon gases which supply the carbon for carburizing. In order to *apply* this principle, Holcroft & Company in 1935 designed and built a generator to produce such a diluting gas.

This patented development—resulting from original Holcroft research—brought all the advantages of today's gas carburizing process. These include (1) accurate control of case depth and carbon content; (2) exceptionally clean, soot-free work; (3) a notable increase in furnace alloy and tray life; and (4) greater output with much less labor. Because of these advantages, gas carburizing is rapidly replacing pack carburizing throughout industry.

Further details on the process are given in the Holcroft Gas Carburizing bulletin, available on request.

The Holcroft engineering leadership which developed gas carburizing is available to serve YOU in production heat treat work of every kind. And remember—Holcroft offers you COMPLETE METALLURGICAL AND ENGINEERING SERVICE, from designing the furnace to your individual needs through the trial run in your plant. We invite your inquiries.

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characteristics, such as viscosity and flash point. These are valuable in assessing the suitability of an oil, but they do not give the entire story. Practical trials are the only really satisfactory way of determining whether a particular oil is suitable for a given job.

Viscosity is the most important consideration, as the speed of cooling very largely depends on the removal of heat from the metal by convection currents in the oil. While a very fluid oil will give maximum removal of heat by convection and minimum drag-out losses, it is not always desirable because of its high content of relatively low-boiling constituents. These are volatilized during quenching so that the viscosity of the oil increases with use and the risk of fire is also increased. High viscosity oils tend to deteriorate more rapidly because of local overheating.

The effect of temperature on the viscosity of the quenching oil may be objectionable where no automatic temperature control is exerted, since the change of viscosity with temperature may affect the quenching speed. To ensure uniform quenching, the temperature of the oil should be kept within certain limits. To a certain extent, they will depend on the type of oil and the nature and size of the article. Cooler baths do not give a more efficient quench because the viscosity of the oil is the major factor in determining its quenching ability. The decrease in viscosity caused by higher temperatures completely outweighs the slight increase in the rate of cooling that might be expected to result from using colder oil. In practice, oil quenching baths are kept at 85 to 160 F, though some authorities recommend a narrower range.

Semi-Conductive Material in the Transistor

A promising new application of semiconductors, such as silicon, germanium, and some metallic oxides, that may have far-reaching significance in electronics and electrical communication is reported in *Bell Laboratories Record*, Aug., 1948. A simple device, known as the Transistor, has been developed which is capable of performing efficiently nearly all the functions of an ordinary vacuum tube. Two hair-thin wires touching a pinhead of a solid semiconductive material soldered to a metal base are the principal parts of this device. It has no vacuum, no glass envelope, no grid, and no heated cathode. Although it is

DIGEST

still in the laboratory stage, when fully developed, the Transistor is expected to find many applications as an amplifier or an oscillator.

The successful development of the device lies in the unique nature of semi-conductors. These materials have electrical properties intermediate between those of metals and insulators, and their ability to carry electrical current can be changed over wide ranges in various ways. In semi-conductors there may be as few as one current-carrying electron for every million atoms, but this number of carriers may be varied 1000-fold or more by changing the electronic structure of the materials. Thus, in the Transistor the electronic structure of the semi-conductor around the input point is modified by the input current. If the output point is placed in this area, the output current can be controlled by the input current. This control of output current by input current is the basic mechanism of amplification.

How to Use True Stress-Strain Curves in Cold-Working Processes

Authorities on cold working often describe the true stress-strain curve as the key to the behavior of metal during plastic deformation, but they seldom specify how it may be used. E. Voce, in the Summer 1948 issue of *Metal Treatment* (British), outlines some applications for true stress-strain relationships and indicates pitfalls in their use.

The ordinary tensile strength of a cold-worked material is obtainable directly from that of the same material in the annealed condition by multiplying by the strain ratio involved in the cold-working process (provided the cold work is less than that corresponding to the strain at maximum load). Therefore, if an alloy with an unknown degree of work hardening has proved suitable for a certain purpose, a comparison of its tensile properties with those of the annealed alloy will afford a good indication of the degree of cold work.

It is desirable to determine the true stress-strain curve under conditions resembling as nearly as possible those to which the results are to be applied. Up to the necking stress, tension and compression curves are closely similar. Above this stress, the curves diverge because of differences in complex stresses and strains. The conclusion that similar curves result from different cold-working procedures and from different testing methods is important, because it

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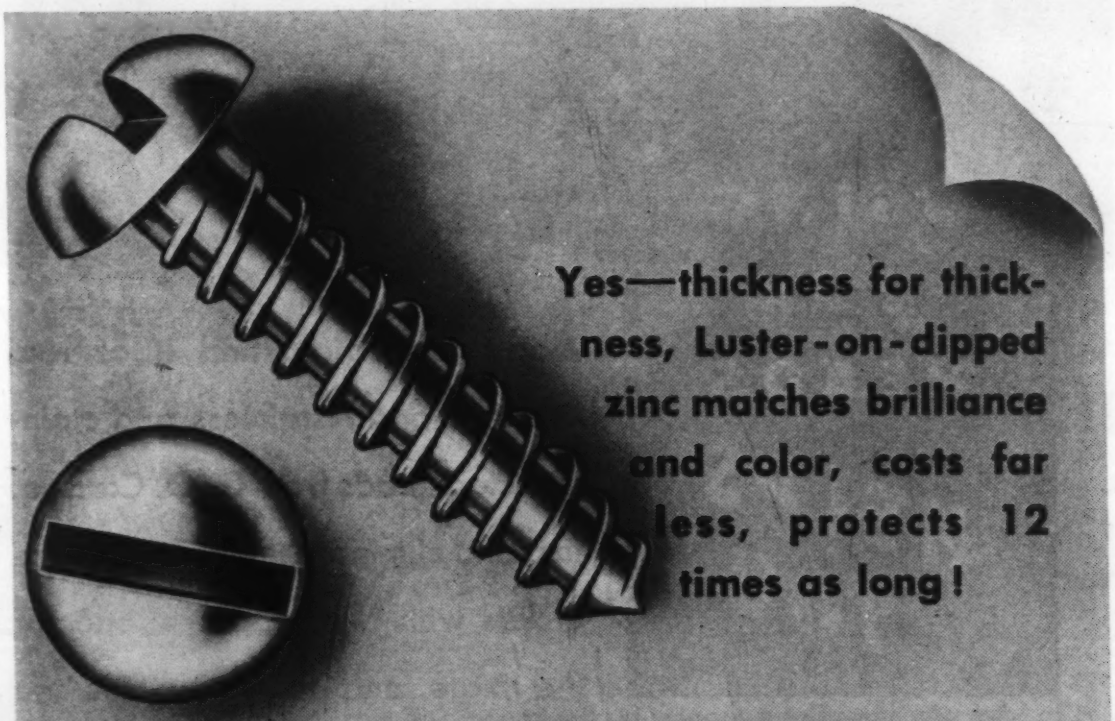
Yes—thickness for thickness, Luster-on-dipped zinc matches brilliance and color, costs far less, protects 12 times as long!

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But think of the saving in time — no racking — just easy basket-dipping in cold solution!

And the difference in cost — inexpensive zinc and Luster-on instead of high-priced, scarce nickel and chrome!

In short, here is a cheap finish that looks like chrome — goes on easier — and costs far less. The answer to a closure maker's prayer!

Mail the coupon today for new Luster-on brochure with full information. Send a sample part from your own production run — we'll gladly process and return it free. 84

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Please send me full particulars about Luster-on* bright dip for zinc-plated surfaces. I am (am not) sending sample for free dip. No obligation, of course.

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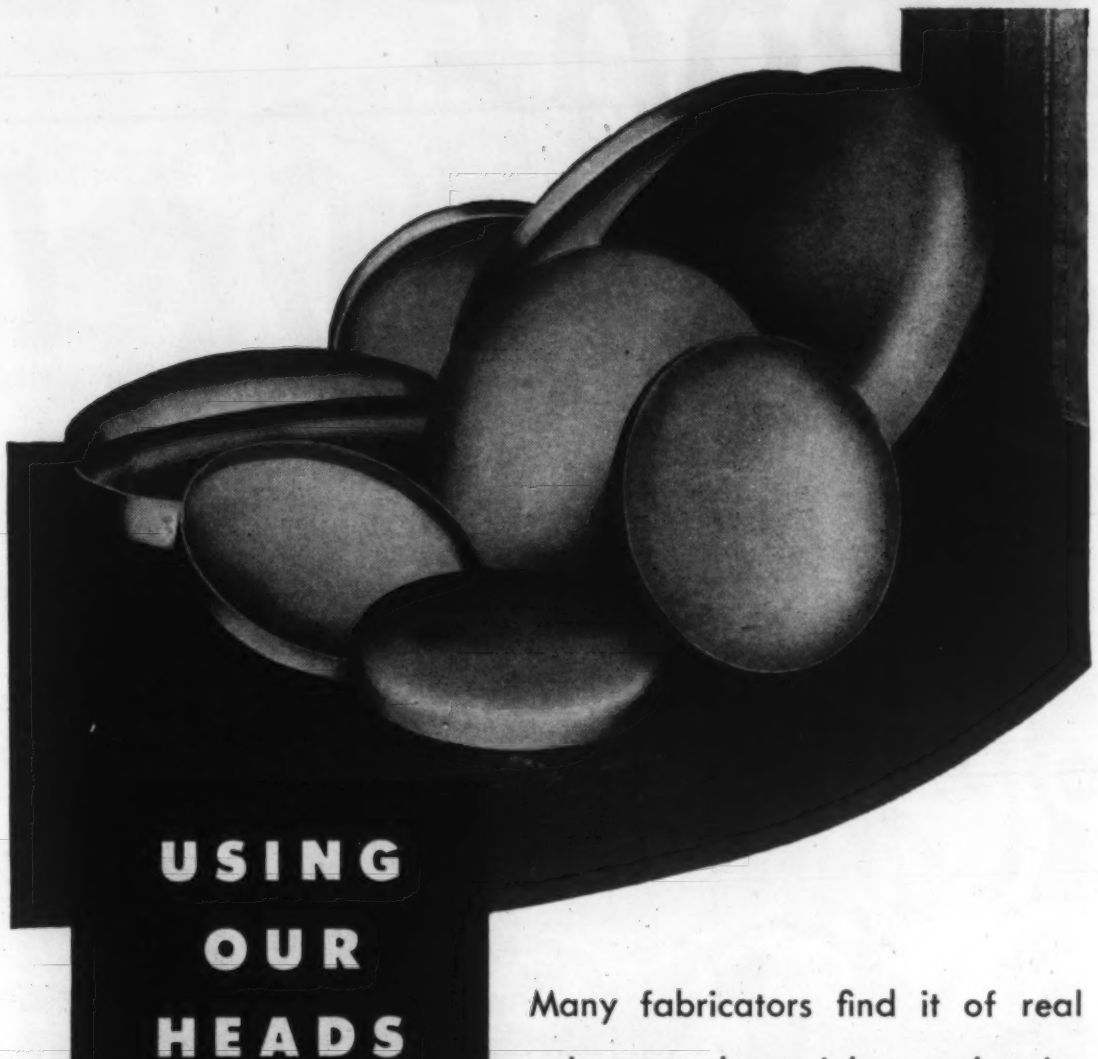

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suggests that stress-strain curves derived from simple experiments can probably be applied generally to such processes as deep-drawing and presswork.

One problem requiring experimental work is the extent to which strains produced by different means, such as cold rolling and deep drawing, may legitimately be combined. The traditional use of percentage reductions has done much to stultify useful thinking because it tends to regard each stage in a series of cold working operations as a fresh starting point, instead of referring all back to the annealed condition. The facility with which strain ratios and to an even greater degree, logarithmic strains, can be combined makes it far easier to take a comprehensive view of the process as a whole instead of regarding it as a series of separate operations.

Experience with Hardenability Specifications for Steels

About three and a half years ago the *Society of Automotive Engineers* and the *American Iron & Steel Institute* Technical Committee tentatively agreed upon a new method of ordering automotive alloy steels in accordance with hardenability as well as chemical analysis specifications. It was hoped that this method of ordering steel would give better control of the response to heat treatment, and assure better properties in finished automotive parts. Last fall the Hardenability Division of the SAE Iron & Steel Technical Committee thought it might be well to make a survey of the automotive, tractor and aircraft industries, and determine the extent to which hardenability specifications were being used, and the results which were being obtained. Consequently, a questionnaire was circulated among a number of users of alloy steels, and 27 replies were received.

Three years ago only one manufacturer was using the new "H" band, or hardenability specifications. By last fall, however, 14 of the 27 companies replying to the questionnaire were using the new hardenability specifications, and eight more were using some sort of hardenability specifications. Only five did not incorporate any kind of hardenability requirements in their specifications.

On the whole, the answers to the questionnaire indicate that considerable improvement has been made in the elimination of the small percentage of heats, which are too low in hardenability to respond satisfactorily to production heat treatments. Distortion, warping, and cracking have been

somewhat reduced. This may be due in part to reduction of maximum hardenability; however, it is believed that the smaller variation in the hardenability of steel obtained from different producing sources is an important factor.

As a general conclusion, it may be stated that the use of hardenability specifications does not change the average performance of steel parts, but that it does eliminate the extremely high and extremely low hardenability heats of steel which formerly would have been accepted under chemical analysis specifications. In this way it reduces the small percentage of trouble which was previously experienced.

High Creep Strength Steel Tubes for Gas Turbines

In the development of gas turbines for large power plants, the closed-cycle type has been of particular interest because recovery of part of the exhaust heat increases the efficiency. G. T. Harris and W. H. Bailey in the Aug. 1948 issue of *Metallurgia* (British) discuss the processing and properties of high creep strength, heat-resisting tubing for the necessary air-heaters and heat-exchangers.

Since the regular 18:8 had insufficient creep strength at 1290 to 1380 F, a special austenitic steel was chosen (Jessop G. 18B with 0.4 carbon, 13 chromium, 13 nickel, 2.5 tungsten, 2.0 molybdenum, 3.0 columbium and 10% cobalt). With careful processing, this steel could be cold drawn into tubes. The creep strength of the cold-drawn tube was about 40% lower than that of the standard bar material. Air cooling from 1740 F did not improve the creep strength, although it did increase the room temperature ductility.

Creep strength values 30% better than those of the standard bar material, however, were obtained by air cooling or oil quenching from 2335 F. Since the tubes must be scale-free, the heat treatment had to be done in an atmosphere controlled furnace. Subsequent oil quenching gave a clean, scale-free surface. Air cooling produced a loose scale that could be readily removed by pickling.

Arc welding seemed to be the best method of welding as the welded joints must be internally smooth to minimize the resistance offered to the gas flow. Good results were obtained with electrodes of the same material. While the creep strength of the joints in the as-welded condition was 18% higher than that of the bar material, a low temperature stress relieving treatment significantly increased this value.

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INSURES AGAINST PLANT SHUTDOWNS

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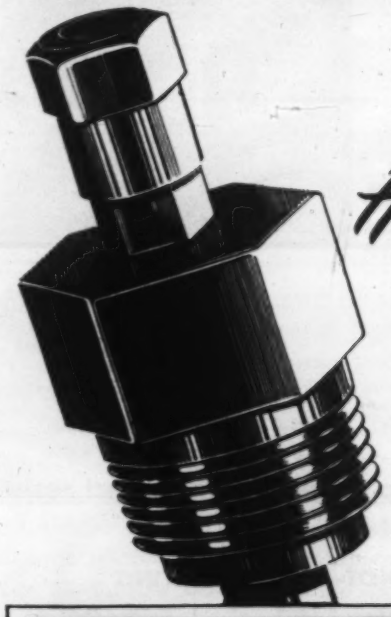

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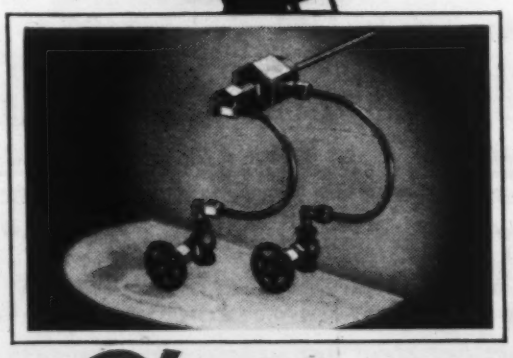
● During the winter season of 1947, 'Surface' installed oil standby equipment in a total of 159 furnaces — 1100 burners, of 'Surface' design, which operated almost daily in one instance for a 58-day period. 61 users enthusiastically recommend this equipment to insure constant plant operation—maintain production—build employee relations and create customer goodwill.



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EASY TO INSTALL— *change over from one fuel to the other is a matter of seconds for most installations.*

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☐ RUSH 8-page bulletin giving specifications and engineering details.

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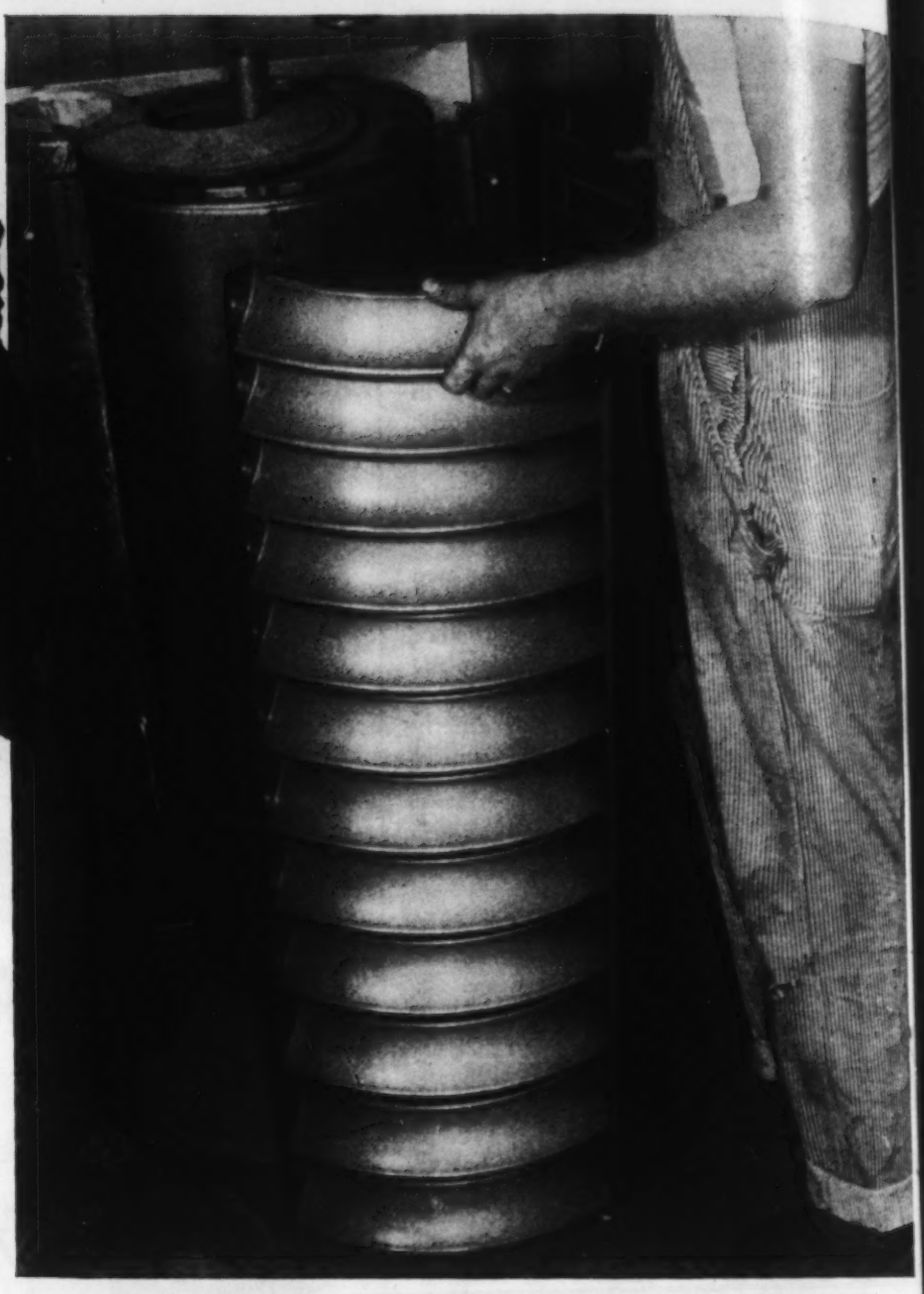
This "2-in-1" metal gives you 7 extra advantages



A workman assembles louvers on the combustion chamber of an oil space heater. The louvers are made of .035 ARMCO ALUMINIZED Steel for high heat reflectivity and resistance to corrosion.

If a combination of heat and corrosion is your biggest product-problem, or you need a metal with high heat reflectivity, ARMCO ALUMINIZED Steel may be your most economical answer.

You get these 7 *extra advantages*:

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3. High heat reflectivity (about 55% for dull finish, higher for extra smooth or buffed).

4. Resistance to corrosion by sulfur and carbon gases at moderately elevated temperatures.

5. A heat-resisting, corrosion-resisting metal at relatively *low cost*.

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7. Creep strength and impact resistance of steel.

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ARMCO-created ALUMINIZED Steel is sheet steel with a tightly adherent, hot-dipped aluminum coating on both sides. It gives your products the surface characteristics of the aluminum coating and the strength of steel. Moreover, this union of metals produces many desirable properties which *neither steel nor aluminum alone can give you.*

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If you are using ARMCO ALUMINIZED Steel in your products, you and your dealers can take advantage of the backlog of public acceptance for the ARMCO triangle and the special-purpose steels it identifies. Thirty-four years of national advertising have made millions of people familiar with ARMCO basic metal quality.

The ARMCO label on products made of ALUMINIZED and other special-purpose steels is a powerful selling-aid. It tells your customers you are using these steels to make products that look better, work better, and last longer. Armco Steel Corporation, 497 Curtis Street, Middletown, Ohio.

ARMCO ALUMINIZED STEEL

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MANUFACTURERS' LITERATURE

Materials

Iron and Steel

Cladmetal. The first published price list, four pages, for the new Rosslyn Metal—cladmetal with a copper core bonded permanently to stainless steel surfaces, which spreads heat and cold quickly and evenly—has been issued by the American Cladmetals Co. (1)

Cold Finished Bar Steels. Both A.I.S.I. and S.A.E. designations and chemical compositions of cold finished bar steels are included in this 28-page revised supplement manual to the 50th anniversary book published by Bliss & Laughlin, Inc. (2)

Expanded Metal. A variety of typical applications and complete specifications of Penmetal Steelmesh, an expanded metal made from carbon steel, stainless steel, aluminum or copper sheets in ¼-, ½-, ¾-, 1- and 1½-in. standard or flattened styles, are featured in this 6-page, illustrated folder, No. 480E, released by Penn Metal Co., Inc. (3)

Cold Finished Bar Steel. Typical uses and mechanical properties of the most frequently used types of cold finished steel bars are included in this 28-page booklet just published by the Union Drawn Steel Div. of Republic Steel Corp. (4)

Steel-Service Plant. The many facilities and personnel of the new plant of Joseph T. Ryerson & Son, Inc. for distributing hot-rolled bars, plates, structurals, sheets, cold finished bars, alloy steel, stainless steel, mechanical and boiler tubes, etc., are interestingly displayed in a 12-page, illustrated brochure. (5)

Stainless Steels. The characteristics of stainless steels and recommended procedures for their fabrication, welding, etc., are contained in this 2-page bulletin published by Tempil Corp. (6)

Nonferrous Metals

Aluminum Bronze and Other Copper-Base Alloys. Physical properties and typical applications of a complete line of aluminum bronze and other copper-base alloy products produced by Ampco Metal, Inc. are included in this 16-page, illustrated bulletin, No. 95. (7)

Bearing Bronze. The frictional properties of Bearium Metal, a bronze for bearings, bushings, thrust washers, and all other services involving rubbing friction, as well as typical bar stock sizes, and individual castings are all included in this 6-page, illustrated folder published by the Bearium Metals Corp. (8)

Magnesium Products. Names of readers interested in a new, illustrated house organ, *The Magazine of Magnesium*, published by Brooks & Perkins, Inc., will be placed on the company's mailing list, if requested. (9)

Corrosion Resistant Nickel-Chromium Alloy. Technical data on Illium "G", a corrosion resistant nickel-chromium alloy designed to resist that most difficult range of acid corrosion in which both acidic and oxidizing environments are encountered, are presented by the Burgess-Parr Co. in their 4-page bulletin, No. 105-A. (10)

Low Melting Alloys. Mold selection, mold preparation and casting of Cerro alloys are the subjects covered by the Cerro de Pasco Copper Co. in the first few of a series of data sheets to be published by that company. (11)

Nickel Alloy Castings. The International Nickel Co., Inc. offers a buyers' guide, consisting of an 8-page list of facilities, specialties and locations of authorized producers of Ni-Hard castings, made from a nickel-chromium white alloy cast iron. (12)

Casting Aluminum Bronze. Detailed procedures for melting, molding and pouring aluminum bronze are incorporated in an illustrated, 8-page bulletin made available by R. Lavin & Sons, Inc. (13)

Parts and Forms

Precision Investment Casting. A variety of small parts that have been successfully precision cast by the Allis-Chalmers Manufacturing Co., as well as a group of questions and answers related to precision casting, are all included in this 4-page, illustrated bulletin, No. 19B6451A. (14)

Alloy Fabrication. Typical applications of the Alloy Manufacturing Co., Inc., fabricating specialists and engineers of stainless steels, aluminum, Monel, Inconel, nickel, and their clads, are illustrated and described in a 6-page folder. (15)

Plated Metals. Applications of pre-plated Nickeloid metals ranging from small clips to entire electrical appliances are discussed in a 20-page booklet in which the American Nickeloid Co. also illustrates hundreds of products that utilize these metals for decorative trim or for functional use. (16)

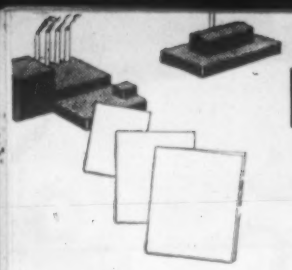
Precision Investment Castings. Excerpts from an article on precision investment castings are compiled into a 12-page, illustrated booklet published by the Arwood Precision Casting Corp. (17)

Permanent Magnets. This 8-page bulletin, No. CDM-12, describes and illustrates cast and sintered Alnico, Cunife, Cunico, Vectolite and Silmanal permanent magnet materials, as well as various permanent magnet holding assemblies, all produced by the General Electric Co. Engineering data and typical applications are included. (18)

Iron Castings. An interesting, 12-page, illustrated reprint issued by the Meehanite Metal Corp. covers in detail the engineering properties of the various types of Meehanite castings as interpreted from an engineering and design standpoint. (19)

Pipe and Fittings. Complete data on Karbate pipe and fittings, including tables of chemical and physical properties, and drawings showing dimensions, assemblies, joining recommendations, etc., are presented by National Carbon Co., Inc. in their latest bulletin, No. M-8800 B. (20)

Expanded Metal. A variety of typical applications and complete specifications of Penmetal Steelmesh, an expanded metal made



MANUFACTURERS' LITERATURE

from carbon steel, stainless steel, aluminum or copper sheets in ¼-, ½-, ¾-, 1- and 1½-in. standard or flattened styles, are featured in this 6-page, illustrated folder, No. 480E, released by Penn Metal Co., Inc. (21)

Designed-Strengthened Metals. The many advantages of using Rigidized—designed-strengthened—metals in a wide variety of products are explained by the Rigid-Tex Corp. in their attractive, 12-page, illustrated bulletin, No. 447. (22)

Molded and Extruded Rubber Parts. The many varied applications of all types of molded, extruded or metal-bonded parts of natural or synthetic rubber produced by the Tyer Rubber Co. are discussed in this 4-page, illustrated bulletin. (23)

Plastics

Hard Rubber and Plastics. This 60-page, illustrated handbook interestingly presents complete technical data on all grades of Ace hard rubber and plastics produced by the American Hard Rubber Co. (24)

Precision Molded Plastics. The facilities, experience, equipment and service of the Consolidated Molded Products Corp., producers of compression-, transfer- and injection-molded plastics, are described and illustrated in an 8-page bulletin. (25)

Plastic Silent Gears. Complete data on a variety of silent gears made from Celeron, a high-strength, nonmetallic, thermosetting plastic, are presented by the Continental-Diamond Fibre Co. in their 8-page, illustrated bulletin, No. CG-25. (26)

Impact Compounds. Bulletin No. 148, four pages, describes and illustrates various products that were molded of impact compounds without extra cost and trouble due to molding difficulties. Drackett Products Co. (27)

Phenolic Materials Check Chart. This handy, slide-rule type of check chart, offered by Durez Plastics & Chemicals, Inc., covers the Durez phenolic materials for a number of typical applications, tables of temperature conversion, weights and cubic equivalents, and specific gravities of various structural materials for comparison with specific gravities of the Durez materials. (28)

Laminated Plastic. The many applications of Formica, a laminated plastic product made with synthetic resins of the phenolic, urea or melamine types and cured into a hard compact material by heat and pressure, are described and illustrated in an 8-page folder, No. 1b-12, issued by Formica Insulation Co. (29)

Molded Plastic Trim. A wide variety of plastic, or plastic and metal handles, pendants, knobs, controls, pulls and dials are profusely illustrated and described in this 8-page bulletin, issued by the Grigoleit Co. Specifications are included. (30)

Injection Molded and Extruded Plastics. The facilities of the Elmer E. Mills Corp. for producing injection molded and extruded plastics, their complete line of thermoplastics, and the many applications of these plastics are all interestingly described and illustrated in an attractive, 48-page catalog. A detailed plastics properties chart is also included. (31)

Nylon-Covered Wire Ropes. Three types of Wirelon ropes—wire rope covered with du Pont nylon which resists fatigue, abrasion, rust and corrosion—are described and illustrated in an 8-page, pocket-size folder released by Rochester Ropes, Inc. (32)

Sheet Plastic Beading Machine. The Thermobeader, a new beading machine designed exclusively for beading straight edges of thermoplastic sheet, 0.005 to 0.020 in. thick, on a high-speed, repetitively uniform production basis, is described and illustrated in a 6-page folder, No. 4703, issued by the Sheet Plastics Equipment Div. of the Taber Instrument Corp. (33)

Nonmetallics

Synthetic Rubbers. An 8-page, illustrated notebook which contains information on laboratory results and industrial applications for Neoprene products has been offered by the E. I. du Pont de Nemours & Co., Inc. Specifications are included. (34)

Pipe and Fittings. Complete data on Karbate pipe and fittings, including tables of chemical and physical properties, and drawings showing dimensions, assemblies, joining recommendations, etc., are presented by National Carbon Co., Inc. in their latest bulletin, No. M-8800 B. (35)

Molded and Extruded Rubber Parts. The many varied applications of all types of molded, extruded or metal-bonded parts of natural or synthetic rubber produced by the Tyer Rubber Co. are discussed in this 4-page, illustrated bulletin. (36)

Methods and Equipment

Heat Treating

Malleableizing Furnaces. Controlled atmosphere, radiant tube heating, improved work handling mechanisms, and accurate temperature are all realized when using continuous-type malleable annealing furnaces for modern malleableizing and pearlitic malleableizing operations, discussed in a 4-page, illustrated bulletin, No. SC-140, offered by the Surface Combustion Corp. (37)

Welding and Joining

Welding Products Price List. Bulletin No. W-1, 16 pages, contains a detailed price list of a complete line of hard-facing, build-up rods, electrodes and weldments, produced by the American Manganese Steel Div., American Brake Shoe Co. (38)

Low Heat Welding Alloys. Four new scientific developments in low heat welding alloys, case histories and complete reference charts are featured in an 8-page, illustrated bulletin published by the Eutectic Welding Alloys Corp. (39)

Arc Welding Contest for Engineering Undergraduates. All the rules and conditions of the annual engineering undergraduate award and scholarship program for 1948-49—closing date Apr. 1, 1949—can be found in a 24-page booklet available from the James F. Lincoln Arc Welding Foundation, sponsor of the contest. (40)

Forging and Forming

Hydraulic Presses and Power Tools. A complete line of hydraulic presses and power tools, ranging in capacity from 100 to 6000 tons for high-speed production and accurate forming of sheet metal parts to any desired shape, is described and illustrated in a 12-page bulletin, No. 285, offered by the Baldwin Locomotive Works. (41)

Precision Machines for Die-Less Duplicating. A complete line of Di-Acro precision machines for die-less duplicating parts or pieces to die accuracy without time delay or expense of dies is described and illustrated in a 40-page catalog offered by the O'Neil-

New MATERIALS AND EQUIPMENT

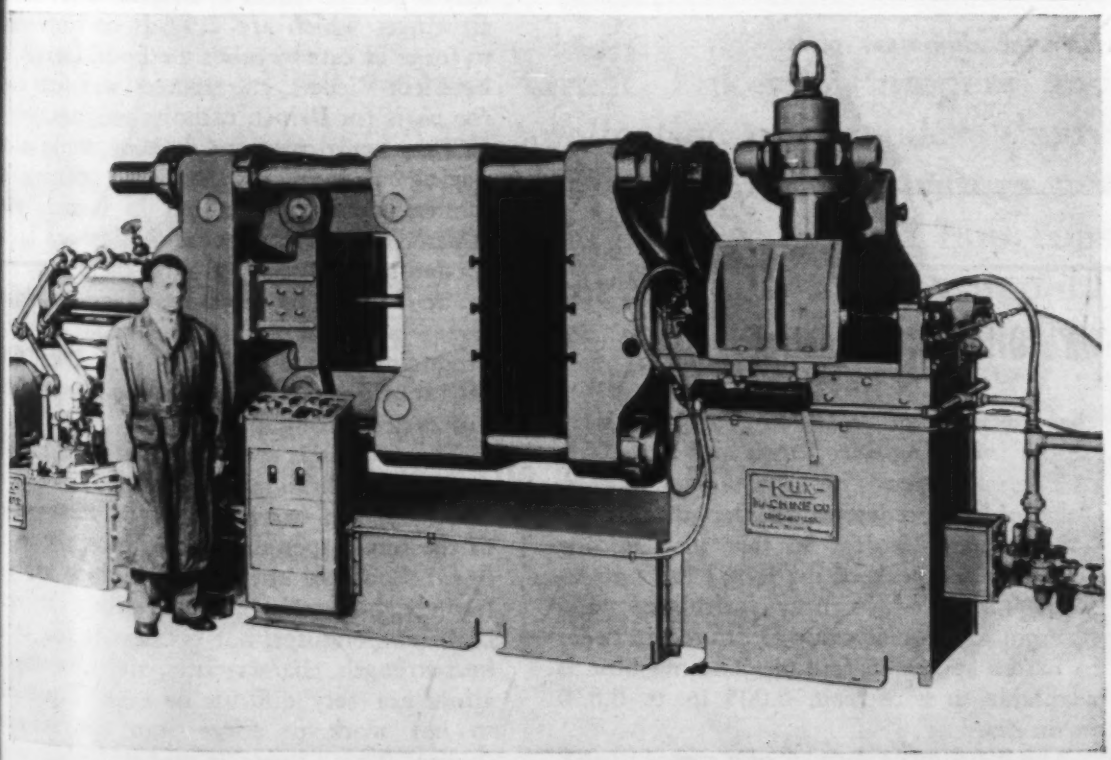
Die Casting Machine Produces 30-Lb. Castings

What is claimed to be the world's largest standard die casting machine has been introduced by the *Kux Machine Co.*, 3940 W. Harrison St., Chicago. Available in three different models, this machine having 800 tons locking pressure will form castings in zinc weighing up to 30 lb. and in aluminum weighing up to 10 lb. High injection pressures are utilized reaching as much as 40,000 psi.

The machine has a die space of 40 in. by 25 in. between the tie bars and 17½ in. of die separation. It is hydraulically operated and electrically controlled. Speed of operation is practically the same as on smaller machines with an average of 3 to 4 zinc casting cycles or 2 aluminum casting cycles per min. being possible.

As a gooseneck plunger type machine, Model BH-40 will produce zinc, lead or tin die castings, and has its self-contained melting pot and furnace incorporated within the frame of the machine. For production of aluminum, magnesium or brass castings, the machine, Model HP-40, has a cold chamber hand ladling injection unit.

Constructed as a convertible machine, Model BH-40C uses a gooseneck plunger mechanism for zinc castings and a cold chamber hand ladling unit for aluminum with conversion from one style of die casting to the other, requiring a minimum of change-over time. Complete stroke control of die opening and closing is built into the electrical circuit so that the die plates can be opened or closed the amount desired or stopped in any position of the 17½-in. total separation stroke.



This die casting machine is reported to be the world's largest standard design.

Case-Hardening Paste Useful for Selective Hardening

A paste that does case-hardening without special equipment has been developed by *Denfis Chemical Laboratories, Inc.*, 172 Pacific St., Brooklyn 2, N. Y. An advantage of this paste, called Carburit, is its ready use for selective hardening.

The section to be hardened is covered with the paste and the work heated to about 1700 F. A case 0.010 in. thick will form in 5 to 7 min.; 25 to 30 min. are required for a 0.040-in. case. After heating with Carburit in place, the work is cooled and reheated to 1500 F. Then the paste is knocked off and the work is quenched. The hardness produced in various irons and steels compares favorably with that produced by other known methods.

Because it is applied in paste form, it is useful for selective hardening. The paste can be applied to only part of the work, or to the entire surface, as desired. Any source of heat can be used with Carburit. When a furnace is available, the heating can be accurately controlled, but a field forge or other means of heating will produce satisfactory results. The temperature is then gaged by the color of the work.

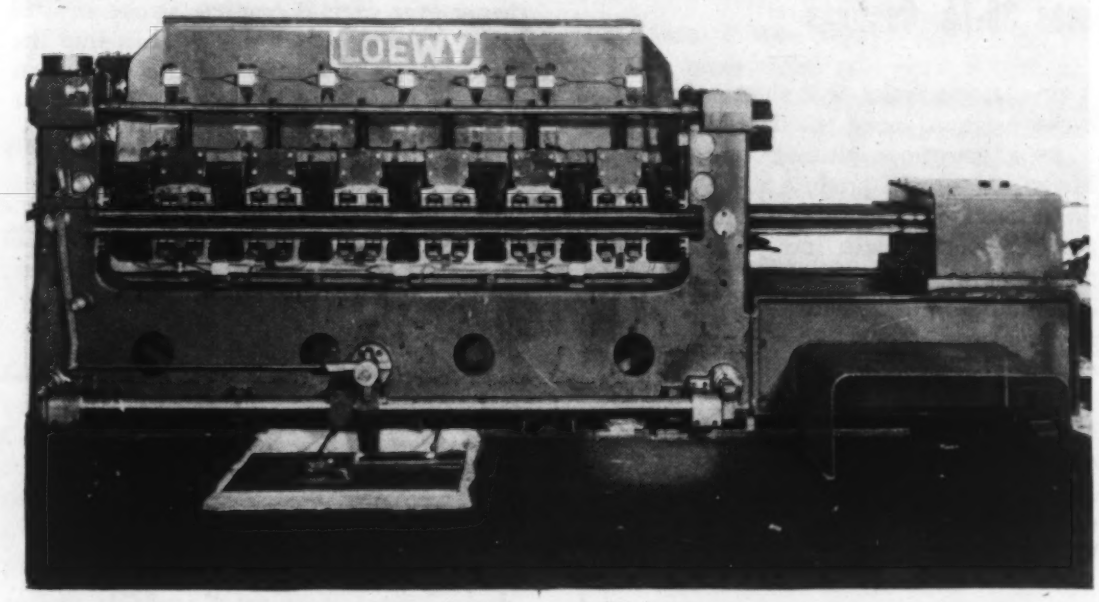
Shearing and Trimming Lines for Aluminum Plate

Equipment for production of flattened, edge-sheared and cut-to-length plate has been designed and built by *Loewy Construction Co., Inc.*, 570 Lexington Ave., New York. There are two complete lines in the group, one for ½ in. by 104 in. by 33 ft. and the other 0.200 in. by 105 in. by 16 ft. Each line consists of feeding tables, backed-up type leveller, pinch rolls, edge trimmer, up-cut shear and gage table. On the heavy line the plates are loaded singly from pile by a vacuum lift un-piler, and after being processed, they are removed singly by a similar vacuum type piler.

The back-up type roller leveller is of unique design. The bottom nest of rolls can be dropped out of bending position quickly or returned without disturbing the set of the machine. The top nest of rolls have special designed back-up roller nests, which operate through mechanism to flex the top work rolls.

The edge trimmers are of the rotary shear type. The knives can be adjusted in two planes. In a vertical plane the top knives can be raised or lowered or they can be moved forward or backward from the perpendicular axis of the knives. In a horizontal plane the lower knives can be adjusted axially for clearance or wear. Reciprocating guillotine scrap cutters are provided operating from a separate drive motor so as to match scrap speed and chop the short lengths. The arrangement of the knife head assemblies is such that the machine can be used as a gang slitter by locating the knife arbors in the heads by means of tapered bores.

Each line has two operating stations from which the whole line is controlled.



Back-up type roller leveller for aluminum plate.

Fatigue Testing Machine for Wire Offers New Controls

A rotating-beam fatigue testing machine for wire has been developed by *Hunter Spring Co.*, Lansdale, Pa. The instrument permits applications of fatigue knowledge such as: (1) control charting of wire drawing processes, (2) wire acceptance on the basis of statistical analyses of fatigue data, (3) studying variations of fatigue characteristics throughout a wire lot, (4) predicting wire life in dynamic service—a quality control characteristic, (5) using fatigue strengths and endurance limits as quality indexes, and (6) determination of fatigue characteristics of small wire as a basis of design involving wire forms and parts.

The instrument's design involves looping a sample of predetermined length through a complete 180 deg. so that the bending stress (at the peak of the loop) can be perfectly predicted, simply calculated and brought to as great value as desired in order to hasten specimen failure. The machine is adaptable to wire from 0.005 in. to 0.030 in. in dia.

The instrument consists of a motor driven chuck (3600 rpm.) and bushings to position that end of the sample which is clamped in the chuck. The bushing can positioned with accuracy to 0.001 in. T supporting guides mounted on Alnico m nets hold the specimen in a horizon plane, prevent vibration, and can be po tioned anywhere on the steel apron of instrument. The test is automatically t minated as the specimen breaks and actua an electronic circuit to stop the motor a the timer simultaneously.

● A new low temperature bronze b permanent repair alloy for many industr repair and maintenance applications is n available from the *John Hewson Co.*, Wall St., New York 5. The repair all handles like putty at 300 F and fuses w the metal surface under repair. Manuf turer states that finished repair can machined, filed, drilled and tapped, a that the low temperature required will n cause crystallization or distortion. Also, will not corrode, run, crumble, shrink, dry out, and works with any metal exc aluminum or its alloys.

British Centrifugal Casting Process Introduced to This Country

The centrifugal casting process know as the Centri-Die method and developed i England has been acquired by *Leban Steel Foundry*, Lebanon, Pa., for use in th country. The process utilizes permanen molds and produces cylindrical and tubul structures which are difficult or impossibl to forge or cast by other methods. Develope by Firth-Vickers, the process was first use for parts for British turbojet engines.

This centrifugal permanent mold allo casting process involves the casting o molten metals and alloys in heavily con structed molds while the molds are bein rotated at high speed around their axes. Th molten metal is deposited and solidifie under pressure within the mold, thereb producing a symmetrical or cylindrical rin of high density with excellent structura properties throughout.

The process is specifically adapted to pro duction of high-melting-point alloys an steels ranging from the carbon steel grade to the new super-alloy types recently devel oped. Some of these compositions are ex tremely heat-resistant and strong at very high temperatures, but because of this same heat-strength characteristic, the new super alloys are very difficult or even impossible to hot work or forge into conventional shapes. This process is said to be the solu tion to this problem.

Every automobile built today uses parts made of N-A-X HIGH-TENSILE STEEL

Since 1940, when Great Lakes Steel pioneered the application of high-tensile, low-alloy steel to cold-stamped automobile bumpers, there has been a growing trend to N-A-X HIGH-TENSILE STEEL in the automobile industry.

Today, every car manufacturer is using the inherent better properties of N-A-X HIGH-TENSILE STEEL for some part of his automobile.

Bumpers and grilles – hoods and fenders–body panels and deck lids – frames and bracings – wheels and hub caps represent a few of many applications of N-A-X HIGH-TENSILE STEEL to the modern car.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify–
N-A-X
HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division • Detroit 18, Michigan
UNIT OF NATIONAL STEEL CORPORATION

WHEN Firth-Vickers of England signed their reciprocal agreement with Lebanon of U.S.A. for a complete exchange of ideas, information and foundry practices, it meant a lot to you.

For now you can have the advantage of the best in alloy castings which has been developed *both* in this country and in Europe.

Of great importance is the "centri-die" process of making centrifugal castings in permanent molds. Firth-Vickers developed this process to make possible the Rolls Royce, De Havilland and other jet engines. Here at Lebanon we are finding applications not only for airplane engines but also in equipment for the oil, chemical, paper and pulp, mining and other industries where corrosion and heat make service conditions severe.

When you talk to Lebanon about alloy castings you *know* you are talking to experts with a wealth of information available.

LEBANON STEEL FOUNDRY • LEBANON, PA.

"In The Lebanon Valley"

The Agreement between Firth-Vickers Stainless Steels, Ltd., Sheffield, England and the Lebanon Steel Foundry, Lebanon, Pa., U.S.A. provides for complete exchange of metallurgical and engineering data, and foundry techniques and practices. This understanding between Lebanon and the largest producer of alloy castings in Europe pools the technical knowledge and experience of both sides of the Atlantic for your benefit.

Write now for this FREE BOOKLET "Centri-die Centrifugal Castings"

Here is a clear explanation of the practical advantages to you of the Firth-Vickers Centri-die method of making alloy castings centrifugally in permanent molds Of interest to executives and engineers who want to keep abreast of new manufacturing and production methods. Write for Bulletin H.

LEBANON ALLOY AND STEEL Castings

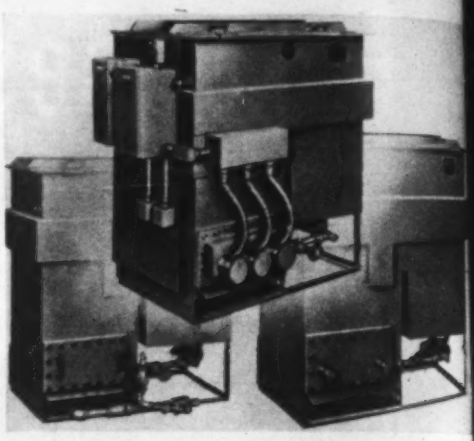
CIRCLE L

Degreaser Designed for Quick-Conversion Heating

Announcement of a two-dip hand-ope ated unit designed for the cleaning medium-size metal parts of all kinds machine shops, production, assembly, a maintenance departments has been made *Detrex Corp.*, Detroit 32.

This unit can be heated by steam, gas electricity; it can also be furnished for co bined gas-and-steam or gas-and-electric he ing. A feature of this new design of equi ment is the standardization of main bo construction so that it can be converted fro one type of heating to another where se sonal changes in heating method give add economy, or convenience.

The degreaser employs the immersio solvent-vapor degreasing process. It r



Immersion-solvent-vapor degreaser wi standardized body construction to facilita interchange of heating means. Machine left is steam-heated; center, electric-heate and at right, gas-heated.

moves grease, oil and similar materials an leaves all surfaces, external and internal clean and dry. To operate, the parts ar simply lowered into boiling solvent, trans ferred within the machine to a cool solven rinse compartment, and after a few second they are removed through the solvent vapo zone.

All interior surfaces of the equipment are protected with a molten zinc coating which is sprayed on after fabrication. It i also available built of corrosion-resistant nickel-steel.

Production capacity is rated at 1000 lb. of steel parts per hr. This unit will immer sion-clean parts that will go into a space 18 by 21 by 12 in. deep; and shafts up to 4 ft. in length can be cleaned by suspending them in the vapor zone. Floor space occu pied is about 10 sq. ft., and the net weight is approximately 500 lb.

Contact Electrodes Are Easy to Use

A new type of manual arc welding elec trode, designed for contact welding, is now being produced by *North American Philips Co., Inc.*, 100 E. 42 St., New York.

These new electrodes, available in lime ferritic, iron oxide and organic types, have

Impco Reverses a Trend

Extra Capacity at No Extra Cost

The versatile Impco 22-ounce machine is now equipped with a new heating cylinder which is consistently shooting 30 ounces of Polystyrene.

To insure maximum production, servicemen make unsolicited calls regularly. Spare parts are stocked in New York, Chicago, San Francisco and other strategic points.

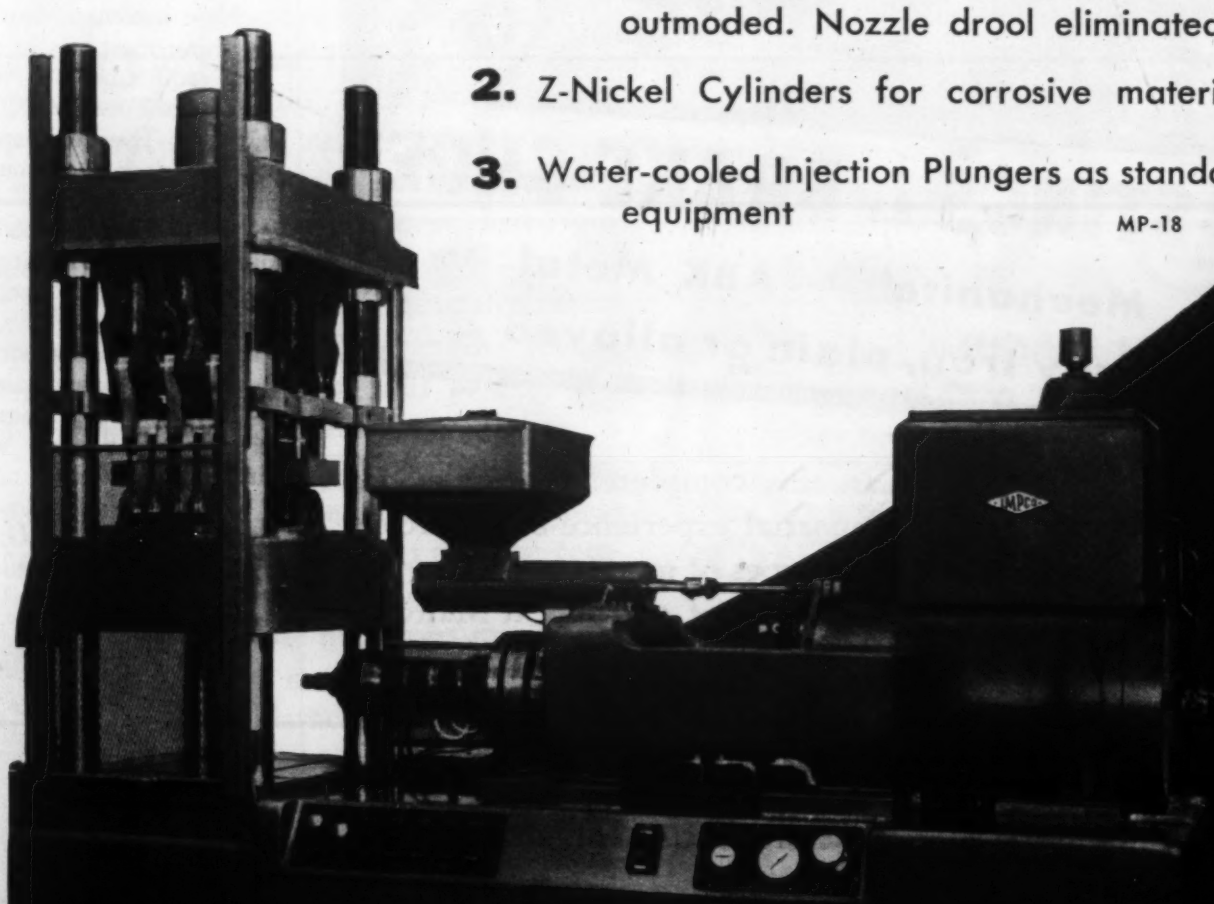
Added Features Pioneered by Impco

1. Molding Nylon is no longer a problem. Sieve plates and screen packs are outmoded. Nozzle drool eliminated

2. Z-Nickel Cylinders for corrosive materials

3. Water-cooled Injection Plungers as standard equipment

MP-18



PLASTIC MOLDING MACHINERY DIVISION

Improved PAPER MACHINERY CORPORATION • NASHUA, NEW HAMPSHIRE

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Wm. B. Given, Jr., President

CASTINGS PILOTED HERE

give you

THE BEST FOR YOUR PURPOSE

CASTINGS BY BRAKE SHOE

• Meehanite® • ABK Metal •

Gray Iron, plain or alloyed

• In this completely equipped experimental foundry you can get impartial experience-based recommendations as to which of these three types of metals will serve you best for your cast parts. It is one building of a group at Mahwah, N. J., the national research headquarters of American Brake Shoe Company.

Whichever metal proves best for you, Brake Shoe foundry techniques can benefit you in both pilot and production foundries at Mahwah, N. J., and in the company's production foundries at Melrose Park, Ill., and Baltimore, Md.

At these plants, castings can be made in widely-used types (light, medium or heavy weight, green or dry sand or all core assemblies) including intricate and special types. Write us about your needs; let us tell you what we at Brake Shoe can do to meet them.

6205

Brake Shoe

BRAKE SHOE AND CASTINGS DIVISION

230 PARK AVENUE, NEW YORK 17, N. Y.

a special type of coating and are said to offer certain definite advantages such as shorter training time for inexperienced welders, and high deposition rates. These contact welding electrodes, two of which can also be used on a semi-automatic basis, permit touchwelding in all welding positions except vertical-up, and have automatic starting and re-igniting properties.

These electrodes offer high deposition efficiency because of their low spatter losses and special coating. The special type of penetration obtained considerably decreases the possibility of undercutting. The electrodes work satisfactorily with standard welding equipment on a.c. or d.c., reverse or straight polarity. Very high currents up to 600 amp. for the 5/16-in. size, may be used.

Automatic Loading Devices Cut Time for Gear Finishing

New automatic loading devices for gear finishing machines to suit different production requirements have been developed by *Michigan Tool Co.*, 7171 E. McNichols Rd., Detroit. The devices are designed for use on both rack and rotary type gear finishing machines.

With these devices it is unnecessary to use arbors for mounting of gears and pinions between centers. Special pneumatic headstock centers are available in which the center acts as an arbor. Stripping from the center is also automatic. Production rates as high as 300 pinions per hr. per machine are being obtained with these automatic devices.

In general the loaders fall into three major classes: (1) Gravity chute feed and unload type, for smaller gears. (2) Chute

Gravity chute feed for rotary shaver supplies 300 pinions per hr. per machine.

feed plus indexing mechanism with positive loading. (3) Jaw tupe loaders for larger gears and cluster gears.

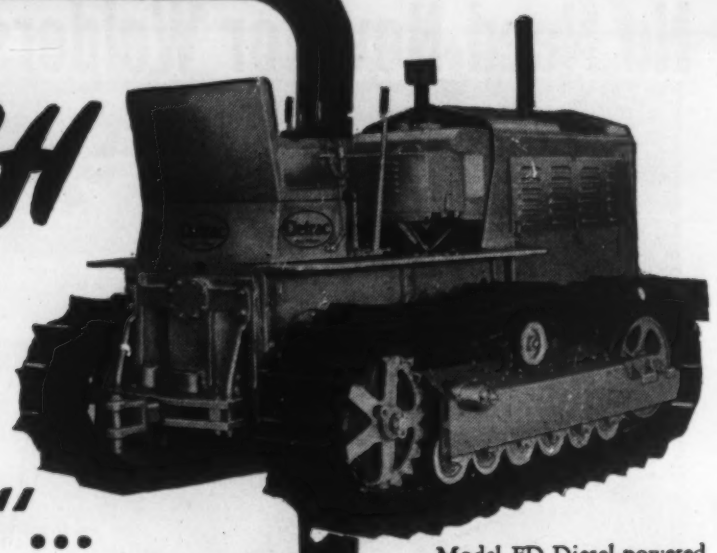
The loading devices for all machines are basically identical. All of these loading devices are so designed as to provide electrical and mechanical interlocks to interrupt sequencing of the machine cycle, in case any part of the mechanism should fail to operate properly for any reason.

STRONG-TOUGH

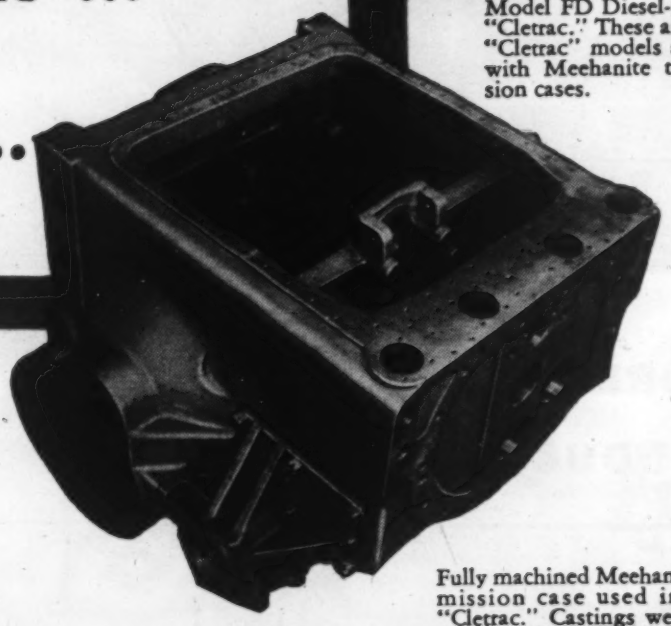
BUILT FOR SERVICE

The Oliver Corporation's "CLETRAC"...

MEEHANITE® Transmission Case...



Model FD Diesel-powered "Cletrac." These and other "Cletrac" models are built with Meehanite transmission cases.



Fully machined Meehanite transmission case used in Oliver "Cletrac." Castings weigh 2200 lbs. Produced by Johnstone Foundries Inc., Grove City, Pa.

The Diesel-powered "Cletrac" built by The Oliver Corporation, Cleveland, Ohio, combines in its design and construction the results of 30 years' research and experience. Only the highest quality in materials and workmanship can meet their rigid specifications.

The Meehanite transmission case illustrated meets their requirements for a high strength, tough, dimensionally accurate unit,—a vital part of the powerful mechanism. Specifications require a minimum tensile strength of 50,000 psi (1.2" Dia. cast-on coupon) and controlled Brinell hardness within the range of 220-240. Castings must be completely free of any defects or misalignment; must be readily machinable; (note numerous machining operations performed) and in fact must embody all the better engineering characteristics for which Meehanite castings are noted.

For the right combination of properties for *your* job specify Meehanite castings.

Write for the Meehanite Handbook and send your casting problems to . . .

METROPOLITAN

PERSHING SQUARE BUILDING

NEW ROCHELLE, N. Y.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry Inc.	Providence, R. I.
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey
Washington Machinery & Supply Co.	Spokane, Washington
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
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"This advertisement sponsored by foundries listed above."

No Need Now for Welders to be Acrobats

Model BPR Power Roll, Model BIR Idler Roll

MORE PRODUCTION AND BETTER WELDS WITH

Model APR Power Roll, Model AIR Idler Roll

Ransome TURNING ROLLS

Welders can make all welds "down hand" with heavier electrodes when Ransome Turning Rolls bring the work into convenient working position for *increased production* and *neater, better welds.*

The improved Ransome line includes three models, with standard capacities from 3 to 45 tons, up to 14 feet in diameter, stationary or self-propelled. (Rolls for heavier or larger work also available.)

Ransome features for trouble-free operation: *unobstructed loading* from either end, due to lowered drive mechanism • *easy rotation* under heavy load, due to anti-friction self-aligning bearings (Models B, C) • *strength where most needed*—exclusive combination bronze and steel reinforced worm wheel • *quick adjustment* for varying diameters • *adjustable variable speed rotation.*

Send coupon for bulletin.

INDUSTRIAL DIVISION

Ransome

MACHINERY COMPANY

DUNELLEN, NEW JERSEY

A SUBSIDIARY OF

WORTHINGTON PUMP AND MACHINERY CORPORATION

PRODUCTION UP 50% LABOR COSTS DOWN

TURNING ROLLS

WELDING POSITIONERS

Ransome Machinery Company
Dunellen, N. J.

Please send Bulletin 228-5 on Ransome Turning Rolls.

Name.....

Company.....

Address.....

Y8-7

Transparent Coolant for Cutting and Machining Operations

A new coolant for grinding wheels a cutters is being marketed by *Arnold Ho man & Co., Inc.,* Canal & Waterman S Providence 1, R. I. The coolant is a tra parent chemical solution. As an emulsi soluble in naturally occurring water su plies, it remains in solution at all norm working temperatures. It is odorless, no irritating, rust-inhibiting.

Fast cooling action of this product is sa to make faster speeds possible. Its hig detergency keeps pumps, lines, machine tools and work free from sludge and di and restricts bacterial growth. No powde or strong alkalies need be added to it f use in any operation.

Among the uses to which the coolant h been put are in cylindrical surface, cut-o and centerless grinding operations, as we as in milling, screw machine, lathe wo and turning, drilling, tapping, and hobbi operations.

● A transparent plastic coating that supplied in a self-contained sprayer has bee announced by *Foster & Kester Co., In* Philadelphia 32, Pa. To release the plast spray, the button on the top of the can pressed. The coating, called Krylon, dri in less than a minute, leaving a clear sati finish that retains the flexibility of the mat rial on which it has been applied. Thi coating is said to have resistance to discolor ation at high temperatures, water, alcoho alkali, acids, mineral oils, grease, an chemical fumes.

New Abrasive Belts Have High Heat Resistance

New abrasive belts, designed with a resi bond to provide extra durability and hea resistance, have been developed by *Minne sota Mining & Manufacturing Co.,* 900 Fauquier Ave., St. Paul, Minn. They are available in widths up to 18 in., in length from 60 in. up, and consist of aluminum oxide mineral grains, in grits from 24 to 120, coated on a flexible cloth backing with a resin bond.

According to the company, prices to be announced shortly are expected to be considerably higher than those for glue bond belts, but the higher cost is expected to be more than offset by increased productive capacity of the new belts.

The new abrasive belts are said to be particularly good on stock removal operations where sharp contours, high belt speeds or frictional heat subject belts to unusual strain.

When this waxer smacks the wall...

GEON leaves no mark at all! You are looking at what is unquestionably the most polite floor conditioner you ever met. Kent Electric Company makes it for scrubbing, wax-spreading and polishing —and they've eliminated what everybody hates most in a cleaner—the denting, marking and scraping of baseboards and furniture.

How? They put on a bumper guard made from Geon polyvinyl resin, thereby taking advantage of its resilience, flexibility and non-marking qualities. They called for the other combination of qualities Geon can produce, too—resistance to age, wear and weather, resistance to heat or cold, ability to combine great strength with either rigidity or suppleness.

Wherever Geon does a job it does it well—and often at less cost than other versatile materials. It can be extruded or cast into sheets, it serves as an impregnant or coating for paper or textiles, it can be molded, it takes to color like you take to your hat. We're really telling you about this floor conditioner so you'll put your own thinking cap on. What do you make that Geon will make better for you?

We make no finished products of Geon or any of our other B. F. Goodrich Chemical Company raw materials. However, we are interested in helping with special problems or applications. For information, please write to B. F. Goodrich Chemical Company, Dept. HQ-6, Rose Building, Cleveland, Ohio. In Canada: Kitchener, Ontario.

Polisher by Kent Electric Corp., Rome, N.Y.

B. F. Goodrich Chemical Company

A DIVISION OF THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • KRISTON thermosetting resins • GOOD-RITE chemicals

New Condenser Cuts Refrigeration Costs Saves Cooling Water

● The Niagara Aeropass Condenser cuts the cost of refrigeration by running compressors at lower head pressure, saving up to 35% of power. It uses no cooling water.

The refrigerant gas passes thru two coils in an air stream. The first, "Duo-Pass" dry coil, removes the super heat by air cooling and condenses oil vapor. The second, condensing coil, drenched by recirculated water spray, condenses by evaporation, transferring to the air 1,000 BTU for every pound of water evaporated. This done at low temperature, no scale forms on condenser tubes to clog air passage.

Between the two coils is the "Oilout", which purges the system of crankcase oil and dirt, keeps it always at full capacity.

The "Balanced Wet Bulb" control holds head pressure at the practical minimum. It automatically proportions the fresh air stream to the condensing load with the full benefit of power-saving on cool days, providing full capacity for peak loads.

Niagara Aeropass design results from over fifteen years' experience condensing by air. It is completely trustworthy for year 'round operation. Users say, "It saves half the difficulties and labor of running a refrigeration plant."

Units range from 10 to 100 tons capacity. For full information ask for Bulletin 103.

NIAGARA BLOWER COMPANY

Over 35 Years of Service in Industrial Air Engineering

Dept. MM, 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

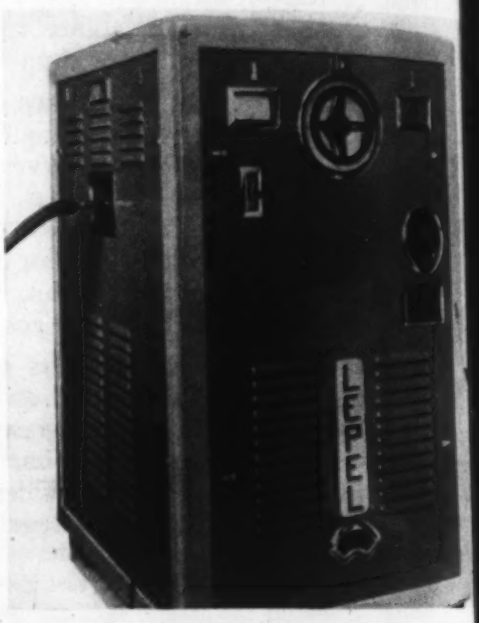
NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

High Frequency Heating Units Are Redesigned

Redesigned high-frequency heating uni have been introduced by *Lepel High Fr quency Laboratories, Inc.*, 39 W. 60 S New York. The new units are availabl in 7½-, 15- and 30-kw. ratings. The com pany reports that the unit interiors are c fire-resisting materials, and operating con trols are arranged for greater convenienc Other changes include improvements in th spark gap holders, thus reducing need fo adjustment of spark gaps, and the use o fibre glass insulation in the high-voltag side of the main transformer.

Applicable for high-frequency heating o ferrous or nonferrous materials, the heatin units can be used without auxiliary equip ment for hardening, annealing, stress relie



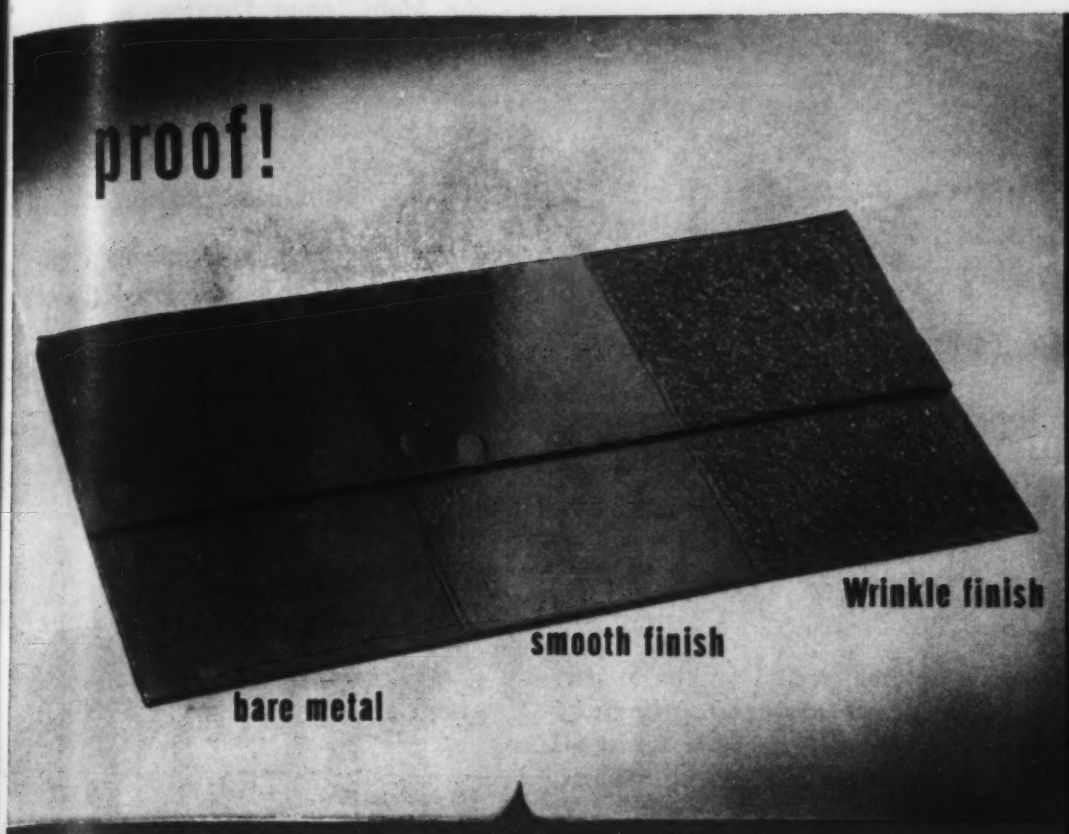
Redesigned high frequency heating units such as this one, are available in 7½-, 15- and 30-kw. ratings.

ing, brazing, soldering and melting. They can also be used with a variety of work coils for heating parts of widely different sizes and shapes, without requiring matching transformers or condensers.

These high-frequency heating units, according to the manufacturer, give full power output, as they deliver their full rated capacity when treating both nonferrous and ferrous metals. Power does not drop off, for example, when the metal being heated passes from magnetic to nonmagnetic stage, or from solid to liquid state.

Recording Instrument Makes Six Records on One Chart

A high-speed instrument, completely electronic in principle, making from one to six different records on one circular chart, has been introduced by the *Foxboro Co.*, Foxboro, Mass. The records are of colored dots so closely spaced as to make virtually continuous lines. The recorder, known as



"ONE-COAT WRINKLE" FINISHES COVER BETTER

...at less cost...on metal sheets

Here is photographic proof of Wrinkle economy and profit in one illustration: weld marks, scratches, and other surface irregularities are completely covered with a single coat of Wrinkle . . . without primer or other surface preparation.

The test panel above was produced by a large and famous manufacturer of air conditioning equipment. It proves conclusively the superiority of one-coat Wrinkle over smooth finishes, applied to sheet metal.

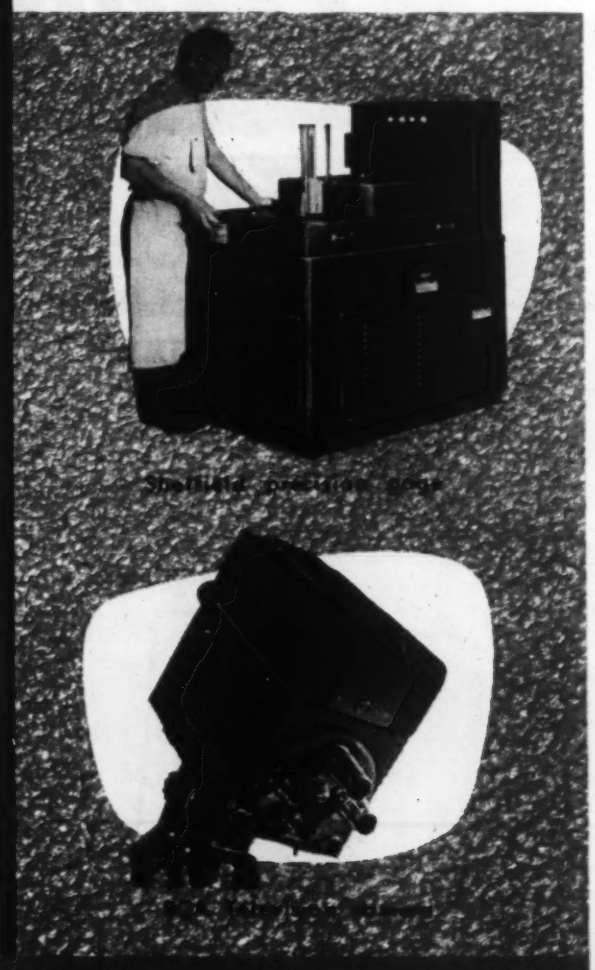
Available Everywhere

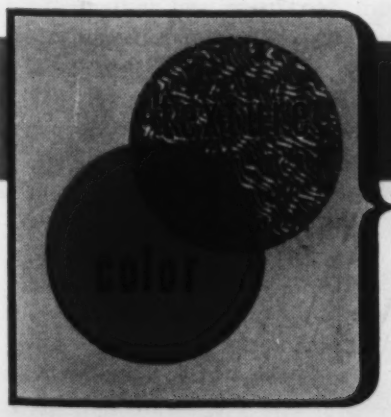
More than 250 authorized and licensed outlets for one-coat Wrinkle finishes are ready to serve you.

Use durable Wrinkle for finishing sheets, castings, forgings, weldments, stampings . . . on components and on complete assemblies.

Wrinkle finishes are available in a wide variety of textures and in unlimited color range, for application to iron, steel, aluminum, magnesium, alloys, wood, and fabrics.

These illustrations show typical Wrinkle finish applications on sheet metal.





NEW WRINKLE, INC. 1171 SPRINGFIELD ST., DAYTON 1, OHIO

FREE: "New Wrinkles in Finishing," a bi-monthly, illustrated magazine devoted to reports on Wrinkle applications and news about developments in Wrinkle finish research, will be sent you without charge. Just fill out and return this handy coupon, today!

X1M

Name _____ Title _____

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"Alodine" solved the problem of paint durability on aircraft. Alodizing provides excellent paint adhesion as well as unusual protection for the metal.
Photograph courtesy of Stinson Division, Consolidated Vultee Aircraft Corp.

Alodized
ALUMINUM
(Coated With "Alodine")
ANCHORS THE FINISH
PROVIDES A NEW ORDER OF DURABILITY IN METALS

"Alodine" is effectively applied by dipping -- in simple immersion equipment; by spraying -- in power washer equipment; or by brushing.

In 2 minutes or less--and at low cost -- "Alodine" developes on aluminum a highly protective corrosion-resistant coating and an excellent paint bond. No electricity is required and the bath operates at a low temperature. Alodizing is adaptable to either small or large plant operation -- to either continuous or intermittent production.

For a lasting paint bond and the utmost in metal protection, specify Alodizing and Alodized aluminum. Write or call for further information.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine *
Duridine *
Alodine *
Lithoform *
Thermoil-Granodine *

RUST REMOVING AND PREVENTING
Deoxidine *
Peroline *

PICKLING ACID INHIBITORS
Rodine *

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

the Multi-Record Dynalog, has only one measuring system, either resistance bulb or EMF type, but a positive-acting switching unit automatically brings the vari-colored pens into recording position at 6-sec. intervals, in any sequence desired. The sequence and number of points may be changed at will.

An innovation in the design is the use of its pen wheel holding the six recording pens, which are magnetically selected in turn and held in recording position by a single pen arm. The recorder may be used for measurement of temperature, pressure, humidity, liquid level, pH, conductivity, speed, and numerous other process variables.

● A new greaseproof barrier material with a creped neutral noncorrosive metal contacting surface, which is backed with a 0.0001-in. sheet of foil as the greaseproof and moisture vapor proof barrier, has been announced by the *Charles F. Hubbs & Co.*, 383-389 Lafayette St., New York 3. The material is creped for flexibility, and is suitable for wrapping bearings and other highly corrodible surfaces. Another grade, with a second sheet of 0.0001-in. foil laminated to the kraft surface for extra strength as well as moisture vaporproofness, is also available.

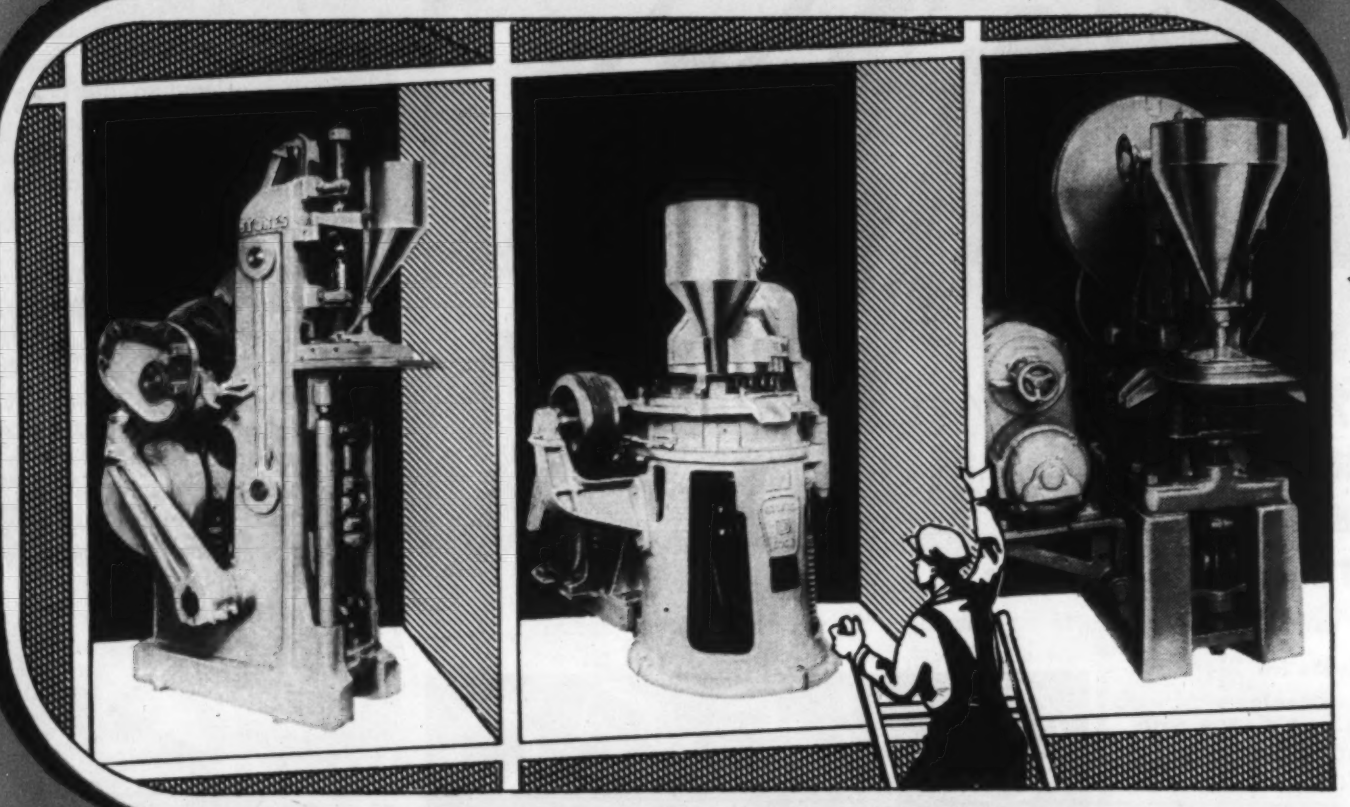
New Plastic for Decorative and Industrial Use

A new plastic composed of glass fibers impregnated with synthetic resins is now being marketed by *Polyplastex United, Inc.*, 92-35 Horace Harding Blvd., Elmhurst, N. Y. It is a thermoplastic material and may be formed by heat and pressure, into both decorative and industrial products. It may also be sewn, laced, glued or riveted, as well as corrugated, fluted, and pleated at an elevated temperature. By means of newly developed electronic equipment and methods the plastic, called Synspun, may be formed and bonded into a variety of designs and patterns.

The plastic is translucent or opaque, as desired. It is dimensionally stable, will not warp or shrink; is not affected by light, heat or atmospheric conditions. It is washable with soap and water; flame-resistant; fungus-proof; impervious to alcohol, ink and grease. It may be had in a wide range of thicknesses and in varying degrees of flexibility or rigidity.

ASK STOKES

You don't buy Powder Metal Presses "OFF THE SHELF"



A PRESS too large or too small for your long-term needs will show in the cost of every unit it produces. For advice on how you can use powder metal at a profit in *your* business; for help in press selection, punch and die design, powder formulas, or related problems . . . consult Stokes.

Here at Stokes you draw on the accumulated experience of more than half a century in press design and operation. Your problem goes through a semi-plant-scale testing laboratory guided by the engineering skill which has pioneered in this field since 1920. Recommendation is then made of the right press from the *complete* line of Stokes specially designed presses for powder metal work.

Stokes also makes Molding Presses, Industrial Tablet Machines, Vacuum Pumps and Gages, High Vacuum Processing Equipment, Tube Fillers, Pharmaceutical Equipment, Water Stills, Special Machinery.

For the right powder metal press for your job, consult with F. J. Stokes Machine Co., 5972 Tabor Road, Philadelphia 20, Pa.

FJS

STOKES KNOWS HOW

Superior

ROUND & SHAPED TUBING

(.010" to 5/8" O.D. Max.)

Available in:

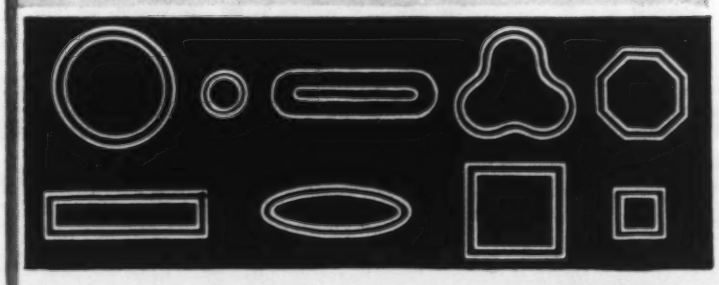
Carbon Steels:
AISI—MT C-1008, 1010, 1015, 1020, 1025, 1035, 1075, 1095

Alloy Steels:
AISI—4130, 4155, 52100

Stainless Steels:
AISI—303, 304, 309, 310, 316, 317, 321, 347, 403, 420, 430, 446, 502 (T-1)

Nickel Alloys:
Nickel, "Monel", "K-Monel", "Inconel"

Beryllium Copper



For the instrument maker, Superior furnishes tubing in cut, multiple or random lengths, shaped to "standard" specifications—or your specialized designs. Flat and elliptical ovals for bourdon springs can be produced in any analysis shown in the accompanying table.

Superior Shaped Tubing Specification and Tolerance Sheets list all the shapes and sizes for which tools are prepared and in stock. While the specification sheets are not available for general distribution, a Superior representative will gladly call at your office to review your dimensional, analysis and delivery requirements.

You are invited to make full use of this Superior service—your request will receive prompt attention.

Visit the Superior Booth #206 at the Third National Instrument Exhibit.

Superior

THE BIG NAME IN SMALL TUBING (.010" TO 5/8" O.D. MAX.)

SUPERIOR TUBE COMPANY

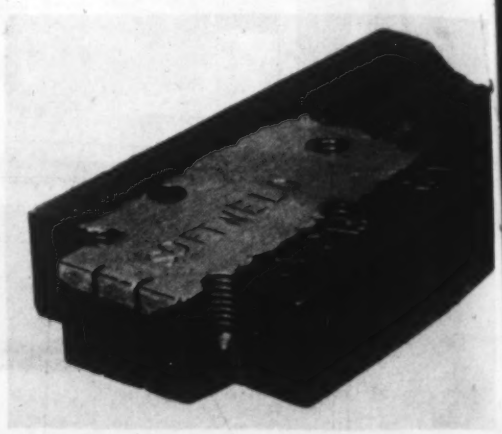
2006 Germantown Ave., Norristown, Pa.

For Superior Tubing on the West Coast, call PACIFIC TUBE CO., 5710 Smithway St., Los Angeles 22, Cal. • ANgeles 2-2151

New Electrodes for Producing Machinable Welds in Cast Iron

Two new electrodes for producing machinable welds in cast iron have been announced. One of these is a 100% nickel electrode produced by the *Hobart Brothers Co.*, Hobart Square, Troy, Ohio. The welds are machinable both in the deposit and line of fusion, and may be drilled, tapped or machined at any point in the weld zone. The electrode is free from fluorides and will not produce injurious gases. The coating is insulated to prevent arcing through when working in confined quarters. The electrodes can be used with either a.c. or d.c. welding current, and are available in 3/32 in., 1/8 in., 5/32 in. and 3/16 in. in dia.

The other new electrode is being produced by the *Lincoln Electric Co.*, Cleveland 1, and is for depositing dense, soft machinable welds in gray iron castings. It is a nonferrous electrode and operates on either a.c. or d.c. current. The electrode is designed to cause the weld to flow over and bond to the cast iron with a minimum of penetration and heating of the base metal. The entire weld area may be drilled, machined, sawed or tapped.

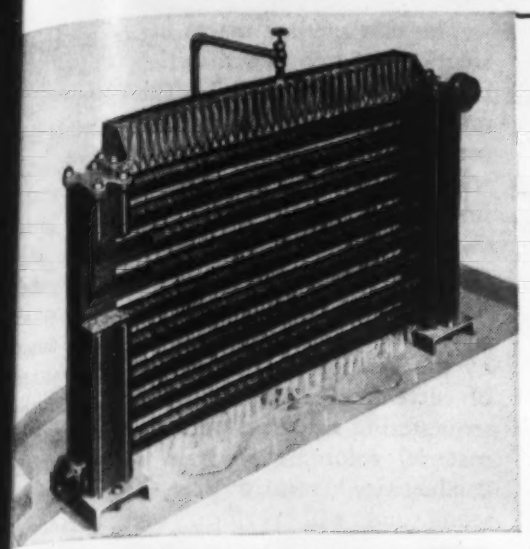


Deposit of Lincoln's new electrode for cast iron shown here has been successfully drilled and tapped.

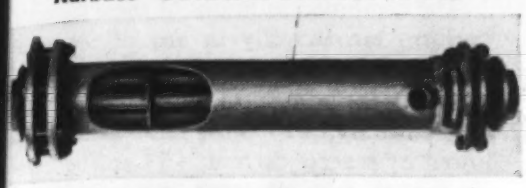
The electrode can be used in both original manufacture as well as repairing broken or defective castings and correcting machining errors. It is used for filling in sand holes and other surface blemishes; building up molds, repairing auto blocks and heads, valve seats, exhaust ports, furnace doors, pulleys, gears, sprockets, cast iron dies, high nickel castings, and dairy metals. The electrodes are available in the 14-in. length in 1/8-in. and 5/32-in. sizes.

Brass Cleaner Combines Two Solutions

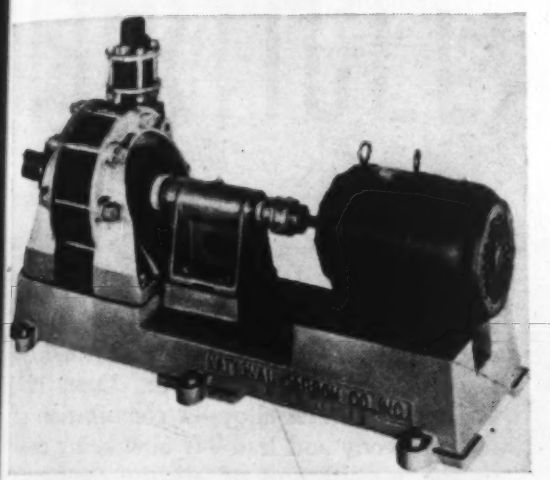
A new process for cleaning brass, and for cleaning copper and copper alloys such as nickel, silver and Monel metal, prior to electroplating, is a recent development of *Oakite Products, Inc.*, 132H Thames St., New York 6.



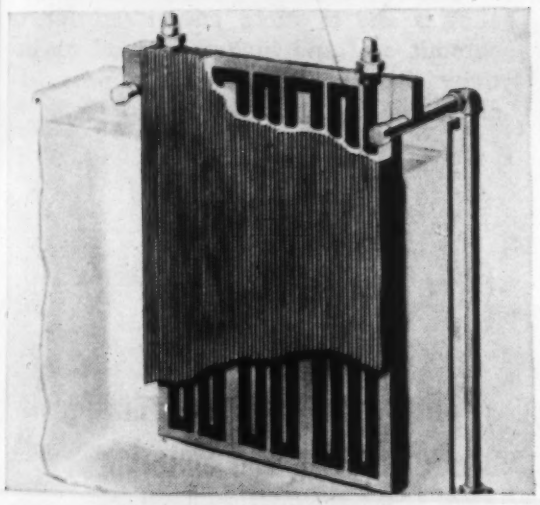
"Karbate" Sectional Cascade Cooler



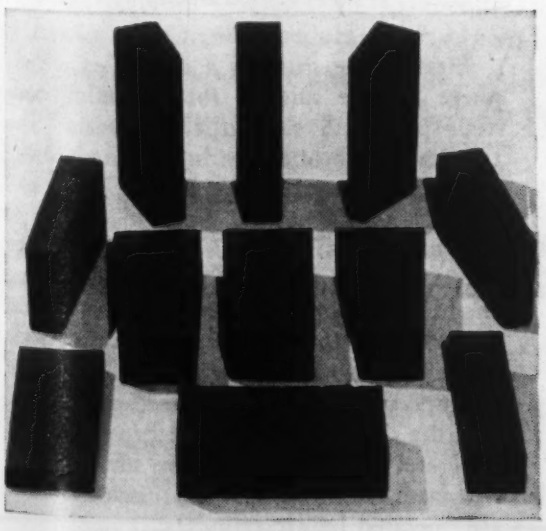
"Karbate" Series 70 Heat Exchanger



"Karbate" Pump



"Karbate" Plate Heater



Carbon Brick for Tank Lining

How to lick corrosion if you pickle or plate metal . . .

USE NATIONAL CARBON PRODUCTS

FOR HEATING, cooling, pumping, and conveying the corrosive solutions used in pickling and plating metal, there's no better equipment than that made of "Karbate" brand Impervious Graphite. This material is chemically inert, immune to thermal shock, easy to machine and install, light in weight yet strong; and has a very high heat-transfer rate.

Operating experience has proved that "Karbate" equipment stands up in sulphuric, hydrochloric, and nitric-hydrofluoric pickling solutions . . . Parkerizing and Bonderizing baths . . . nickel, copper, tin, and zinc plating solutions . . . electro-polishing and Alumilite and Alzak processes.

"National" carbon brick is now extensively used for lining tanks that handle corrosive solutions — particularly nitric-hydrofluoric.

For more details on metal-cleaning systems of standard "Karbate" brand Impervious Graphite units and "National" carbon brick, write to National Carbon Company, Inc., Dept. MM.

These products sold in Canada by Canadian National Carbon Company Limited, Toronto 4

The registered trade-marks "Karbate" and "National" distinguish products of

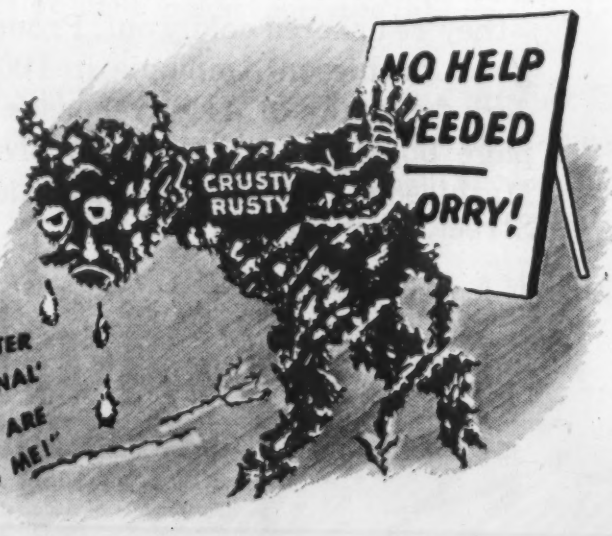
NATIONAL CARBON COMPANY, INC.

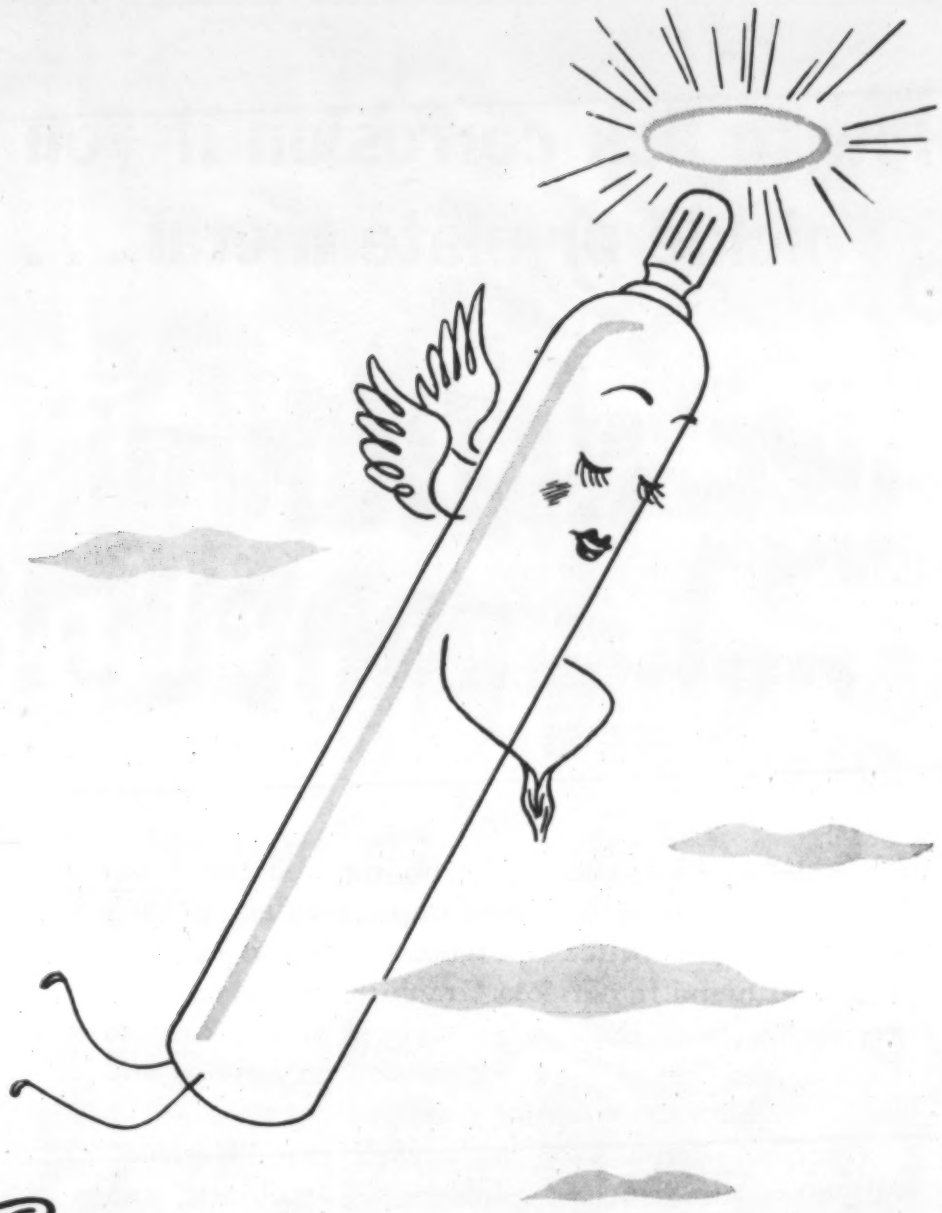
Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd St., New York 17, N. Y.

Division Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco





Gad, but it's Pure!

Purity is bred into Mathieson Ammonia. We purge every trace of foreign element from its forebears—nitrogen and hydrogen—then combine these gases into the purest ammonia obtainable.

And do you think we stop there? Not by your pyrometer! Cylinders are thoroughly checked before each shipment. Valves get a special going over. And as for moisture, non-condensable gases and other impurities—they're ushered coldly out. Prompt deliveries of that good Mathieson Ammonia in 100- and 150-lb. cylinders from any of 44 warehouses. Write for free 40-page booklet: "Ammonia in Metal Treating."
Mathieson Chemical Corporation, 60 East 42nd Street, New York 17, N. Y.

Mathieson
AMMONIA

Ammonia, Anhydrous & Aqua...Caustic Soda...Soda Ash
Bicarbonate of Soda...Liquid Chlorine...Dry Ice...Chlorine Dioxide...HTH Products...Fused Alkali Products...Sodium Chlorite Products...Carbonic Gas...Sodium Methylate

The new method makes use of combined solutions of two new materials, Oakite No. 91 and Oakite No. 91-A. The first of these materials is a specialized cleaner, while the second is an additive which, when used with the former, helps prevent the formation of tarnish on brass parts and gives the resulting solution good chromic acid tolerance. In both the basic cleaner and the additive there are a combination of wetting agents which are not broken down by the heat of the solution or the passage of current, plus special solvents and lime-sequestering agents. In addition, these two-material solutions are said to have high conductivity, remain free from surface scum, and will perform well with hard water.

The combined solutions of these materials perform satisfactorily in any of the established precleaning sequences of the plating industry, including: (1) direct-reverse current cleaning; (2) soak tank method followed by reverse current; (3) anodic cleaning where only one tank is available; and (4) cathodic cleaning.

● Both service life and efficiency of lead anodes are said to be increased through the use of a new alloy developed by the *Division Lead Co.*, 836 W. Kinzie St., Dept. 107, Chicago, Ill. The alloy—a combination of tin, antimony and lead—is now being used in the manufacture of all the company's 71-point and 39-point lead anodes. The alloy is said to afford greater resistance to chromic acid and higher electrical conductivity than plain lead or antimony lead alloys.

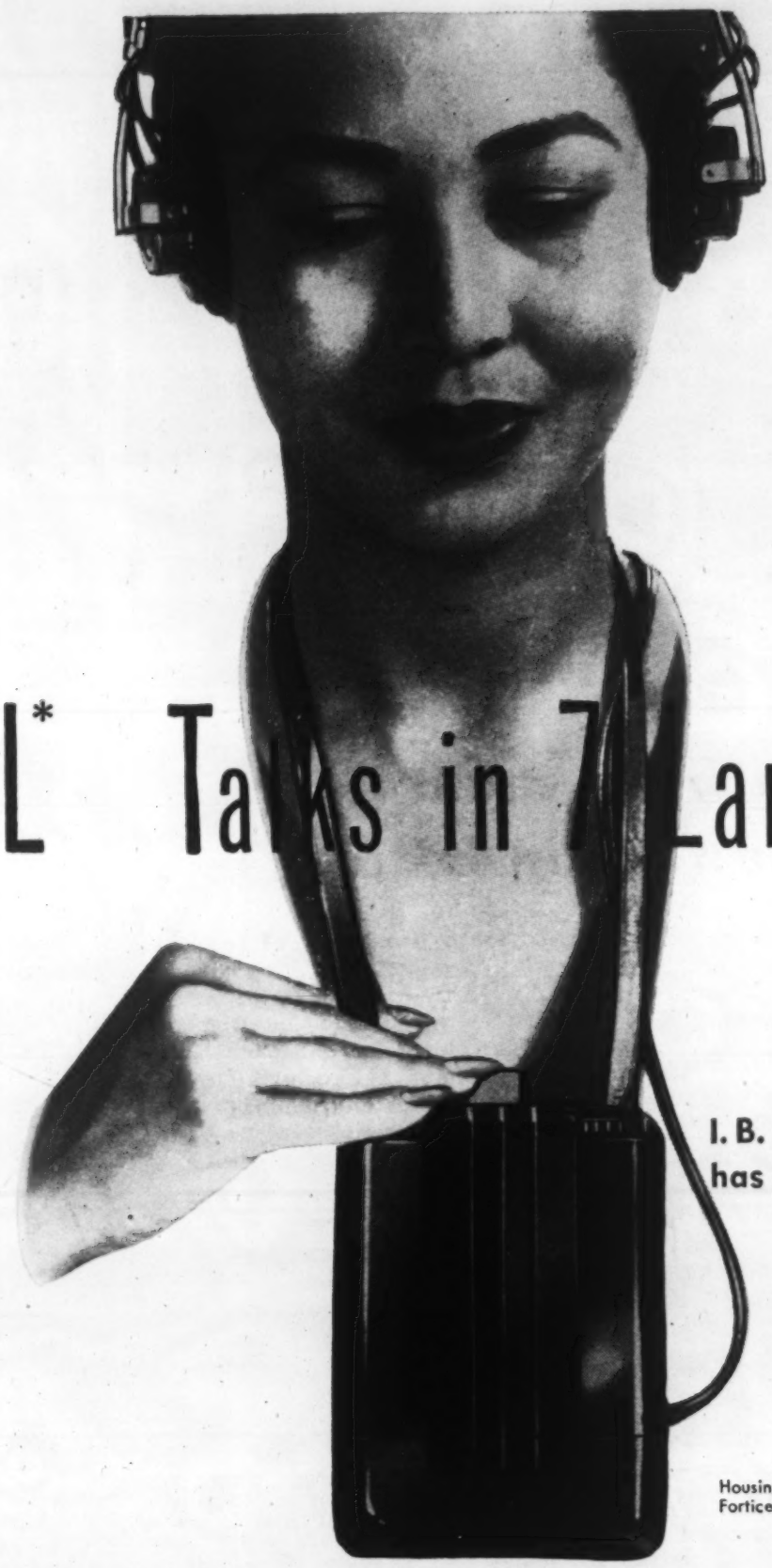
New Furnaces for Hardening, Brazing and Sintering

Three new furnaces have been recently announced by *Lindberg Engineering Co.*, 2444 West Hubbard St., Chicago 12.

First of the three is a controlled atmosphere furnace suitable for hardening both high-speed and air hardening steels. The furnace is also built for brazing and sintering operations. Heating is by Globar elements, and the unit is built to operate at temperatures to 2500 F. A propeller type fan is built into the top part of the cooling chamber to circulate the protective atmosphere within the chamber and thus provide faster and more uniform cooling. Protective atmosphere for both the heating chamber and the cooling chamber is provided by a generator of the proper type for the work involved. Both charge and discharge door are operated by air cylinders.

Second is a continuous flow vibrating

FORTICEL* Talks in 7 Languages



I. B. M.'s Wireless Translator has Molded Forticel Housing

Housing (2 parts) and 2 selector dials molded of Forticel by Plastic Manufacturers Inc.

Simultaneous translation into 7 different languages makes the IBM wireless translating system embodying Filene-Finlay patents a vital part of international conferences. Worn on the chest, it picks up broadcast signals through its neck-strap antennae, and amplifies a translation of the speaker's words in the language the listener selects. Its housing is molded of Forticel—Celanese* cellulose propionate.

Forticel was selected for this important application because of its ideal combination of mechanical and aesthetic qualities. This premium plastic is unmatched in impact and tensile strength, and gives the housing the toughness to withstand continuous handling by delegates, diplomats and visitors—with a generous margin to spare for accidents and abuse.

Forticel has the form retention and low humidity expansion for close-tolerance-fitting of parts. It is light in weight and odorless for wearing comfort. Its lustrous surface only improves with use.

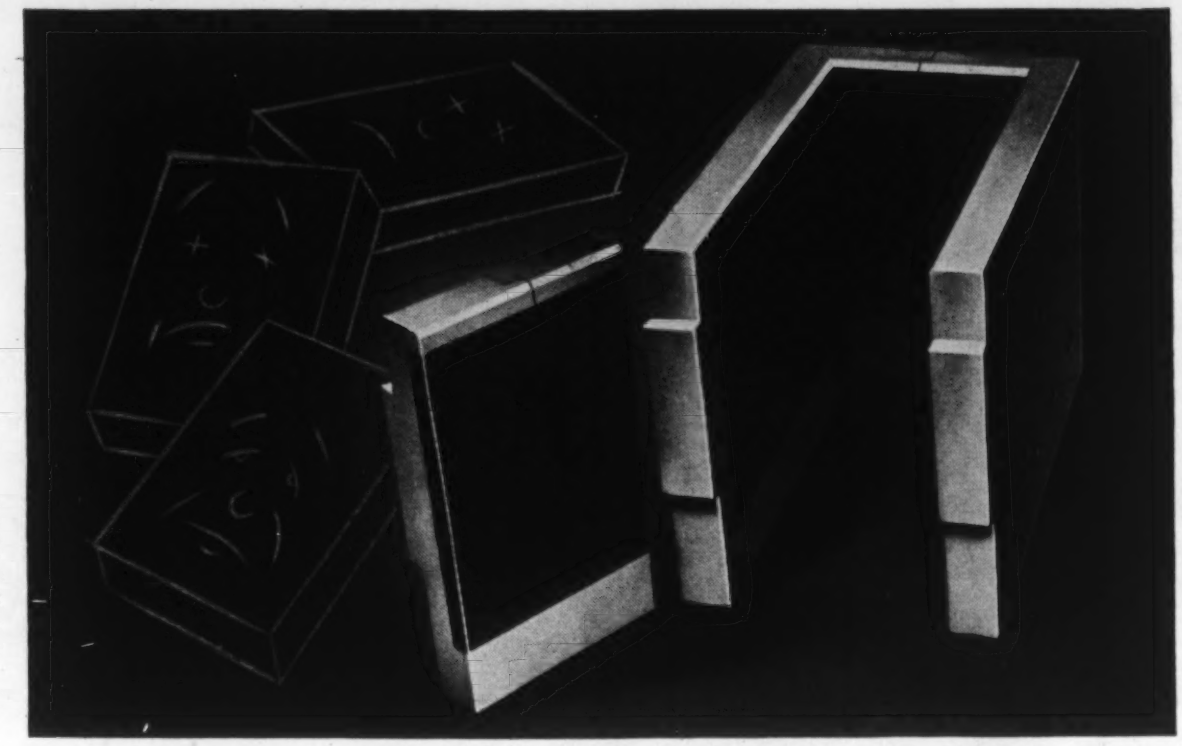
Forticel's molding characteristics are excellent. They include high fidelity to detail, virtually invisible weld lines, and brilliant molded surfaces that need little or no finishing.

When you want to put the best in a product so that the user gets the most out of it . . . when you have exacting molding requirements . . . when you need a definitely superior cellulosic, Forticel is the plastic for you.

CELANESE CORPORATION OF AMERICA
Plastics Division, Dept. D-4
180 Madison Avenue, New York 16, N. Y.

A *Celanese* Plastic

*Reg. U. S. Pat. Off.



This brick mold won't lose face in a hurry!

MOLDS of hard steel and iron were rubbed the wrong way by coarse, abrasive brick. Excessive wear meant frequent replacement of brick-mold faces—and costs showed it!

Now? Now Carboloy Hard Metal faces are used on the molds—and this miracle metal is outwearing the old molds many times.

Surprising? Not to us, or to anyone who's worked with this *hardest metal made by man*. Carboloy's history of fantastic conquests over wear indicates that it could jump the life of some machine or product parts for you—by as much as a hundred times!

You see, *wear-proofing is our business.* Carboloy Cemented Carbides were *developed* to fight wear.

These qualities can go to work for you—to fight wear, and bring you lower costs and boosted production:

- **Extreme hardness**
- **High abrasion resistance**
- **Extreme density**
- **High modulus of elasticity**
- **Low coefficient of expansion**
- **High compressive strength**
- **Corrosion resistance**

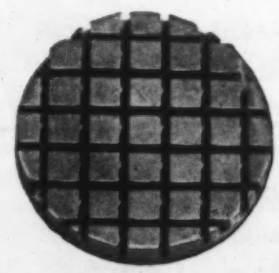
Check these points! Look over your methods and materials for places where wear might be too high. Better yet, call in a Carboloy engineer—let *him* seek out the spots where Carboloy Hard Metal can bring you real savings.

Choose from hundreds of low-cost standards

You'll find a standard to suit your need among Carboloy's huge, comprehensive stocks—it's almost a certainty. Carboloy's economical standards are fighting wear on many fronts. For example—

Here's an item as handy as a screwdriver to have around! Keep a supply of these unground solid Carboloy rods where you can use them in a hurry—for length gauges, flat drills, locating pins, all sorts of places and uses!

You'll never dig a fork into *this* waffle! A gauge anvil of Carboloy Cemented Carbide, used on measuring instruments, brings real savings by reducing the number of rejects due to faulty inspection equipment.

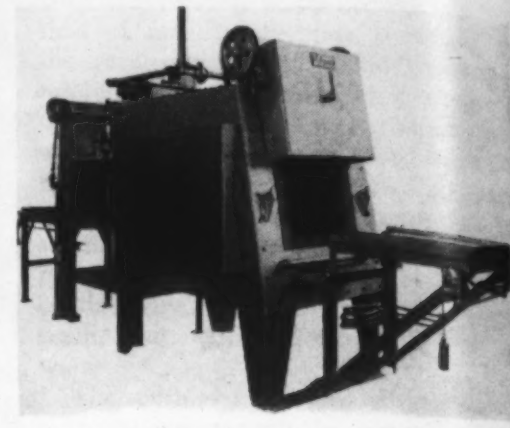


CARBOLOY COMPANY, INC.
11161 E. 8 Mile Road, Detroit 32, Michigan

CARBOLOY®
CEMENTED CARBIDE

HARD METAL
TO REDUCE WEAR ON MACHINES AND PRODUCT PARTS

hearth furnace, a controlled atmosphere unit specially designed for hardening small parts. The vibrating of the hearth moves the work through the work chamber to a chute through which the parts fall into the quench.



This all-purpose controlled atmosphere furnace is suitable for hardening, brazing and sintering operations.

With the vibrating hearth, parts flow by high frequency vibration instead of hopping as the result of intermittent abrupt impulses. Provided with the furnace is an oil quench tank or a salt quench tank for martempering or austempering operations. This furnace is built for temperatures to 1800 F, and is electrically heated by heavy nickel-chromium elements.

The third is a pot furnace featuring cyanide pots that carry a one-year guarantee.

Machine Prepares Blanks for Die Forging

A new machine designed for reducing or preforming forging blanks by rolling to accurately distribute the stock to meet the requirements of the final forging has been developed by the *National Machinery Co.*, Tiffin, Ohio. The machine, being a separate unit, can be used in connection with hammers or forging presses.

This new machine is said to eliminate the fullering and edging operations necessary to prepare blanks prior to impression die forging in a hammer. Requiring practically no skill to operate, it pre-forms in quantity uniform blanks free of shuts and folds. Used as an adjunct to a forging press, it widens the range of application of the forging press.

The machine, called the Reduceroll, is equipped with an air controlled friction clutch, tripped for each pass by a conveniently located foot pedal. The rolls, circular and thus readily machined, are overhung to permit easy feeding, accessibility and quick change. The upper roll shaft runs in eccentric bushings, which permits adjustment of the center-to-center distance of the roll shafts.

The machine is built in five sizes, covering the range of forging jobs handled by the complete Maxipres line, from the No. 1 through the No. 10.

Bethlehem Carbon Tool Steel

The most versatile grade

This unique sheet-metal punch, made by Rotex Punch Company of Oakland, Calif., provides a compact arrangement of punches and dies which are housed in revolving turrets so that the operator can make a quick selection of the punch he wishes to use. It accommodates 17 different punches and a shear blade, all made of Bethlehem XX Carbon Tool Steel.

g tool life and keen cutting edges are provided for e handy Rotex punch by the use of Bethlehem XX on Tool Steel for all punches, dies, punch holders, shear blades. This is a typical use where the basic ad- ages of carbon tool steel make it a logical selection.

CARBON—THE GENERAL-PURPOSE GRADE

carbon tool steels are the best choices for a wide e of tools and dies. Here's why:

They are the easiest to machine of all tool steels.

★ They have a hard case and a tough core.

★ They develop keen cutting edges.

★ They are easy to heat-treat.

lehem X Carbon Tool Steel (0.75 to 0.85 pct on) is recommended for hand chisels and shock s. XCL, XX, and XXX grades have several ranges arbon content: 0.90 to 1.00 for cold-heading die ls; 1.00 to 1.10 for most tool and die work; 1.15 to 1.25 where extra-keen cutting edges and greater wear-resistance are needed for stone-dressing tools, paper-knives, drawing dies, etc.

CLOSE CONTROL OF HARDENABILITY

Easy machining and uniform results in heat-treating carbon tool steel are made possible by our close control of hardenability in the steelmaking process and uniform spheroidize-annealing. Bethlehem's extensive research has established the ideal degree of hardenability for a wide range of applications.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corp.

Export Distributor:
Bethlehem Steel Export Corporation

BETHLEHEM STEEL

ARBON . . . one of Bethlehem's Fine Tool Steels

DURALINK BELT

Combining

ARTICULATION and DURABILITY

It was quite a casting job . . . and an assembly job . . . to make this high alloy belt for a continuous heat treating furnace. But it's typical of the work we are in a position to handle.

1 We have metallurgists capable of designing special equipment to meet conditions of corrosion, high temperature or abrasion and to select the proper alloying elements.

2 We have the foundry equipment capable of turning out sound castings ranging from a pound or two up to six tons per piece.

3 We have the latest in X-ray and Gamma-ray testing apparatus and an excellent control laboratory to be sure your castings are sound.

Possibly you don't need a continuous belt, as illustrated. Perhaps your casting requirement is a retort, grid, roller, pump part, kettle, cap . . . whichever it is, we would like to take care of it for you.

Do you have our General Catalog 4729-G? If not send for a copy

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N. Y.

Los Angeles & San Francisco: KILSBY & HARMON

Detroit: F. B. CORNELL & ASSOCIATES

11-DU-3

Many Tube Forming Operations Performed on New Machine

A process for the forming of tubular sections by a combination of electrical current and pressure has been announced by the *Federal Machine & Welder Co.*, Warren, Ohio. Known as the Westin Process, it has many applications for performing various operations on tubing.

The machines consist of a heating transformer, dies, mechanism for holding and rotating the tube, and either a means of feeding the tube into a split cavity-type die or a means of feeding the two die segments at right angles to the axis of the tube.

The two halves of the split die are insulated from each other, and one side of the die is connected to one side of the heating transformer. The opposite half of the die is connected to the other side of the heating transformer. The tube on which the forming operation is to be performed is secured in the chuck and simultaneously rotated at low speed and fed into the die cavity by either mechanical or hydraulic means.

As the tube enters the die, the current flows from one die segment through the tube and back through the other die segment. The electrical resistance of the tube to the flow of current causes it to heat rapidly in the die, and as the tube is fed into the die it is progressively heated and formed to the shape and diameter of the die cavity.

Some extruding operations on tubing are also possible by using the dies in the manner described in the preceding paragraph to heat the tube (without rotation) in the sections which are to be extruded, then forcing the tube through a die, which will give a longitudinal extruded section on both the inside and outside diameter of the tube.

On some forming applications it is necessary to construct the machine so that the segments of the die can be fed in against the tube, but the principle is still the same.

Some of the applications for this process are: forming steel gas cylinders, upsetting sections of tubing to increase wall thickness, sealing tube ends, necking-down tube sections, and other high-production operations of a related nature on low-carbon or alloy steel, brass and other metals.

Electric Pyrometer Is Portable and Records Up to 2200 F

A portable electric pyrometer recorder or/and controller, so arranged that six points of heat to 2200 F can be recorded or controlled, is now available from *Electric-Arc, Inc.*, 152-162 Jelliff Ave., Newark, N. J. It is said to be fast-acting and precise, and is arranged for simple electrical off-on control.

The pyrometer can be used for semi-

The high-temperature, corrosion-resistant alloys, of which aircraft turbo superchargers are made, are easily and quickly joined by the UNIONMELT welding process.

The UNIONMELT Process

a fast, easy way to join plain and super alloys

The UNIONMELT process of welding electrically, without flash, glare, or spatter, produces sound, high quality welds of smooth, clean finish—welds which while hot are protected by a molten covering of fused special welding composition applied in granular form. When cool, the fused composition detaches itself and no chipping or peening is required to finish the weld.

The high welding currents, characteristic of the process, produce uniform welds of extremely deep penetration at high speeds. In welding alloy steels and non-ferrous metals, special welding rod and sometimes special types of the granular welding material are used to produce weld metal of the composition and characteristics required.

LINDE Engineering Service can help you whether your job involves UNIONMELT welding or any other of the numerous LINDE methods for joining, cutting, forming or treating metals.

Call or write any LINDE office for a copy of booklet F-6077, which fully describes UNIONMELT welding.

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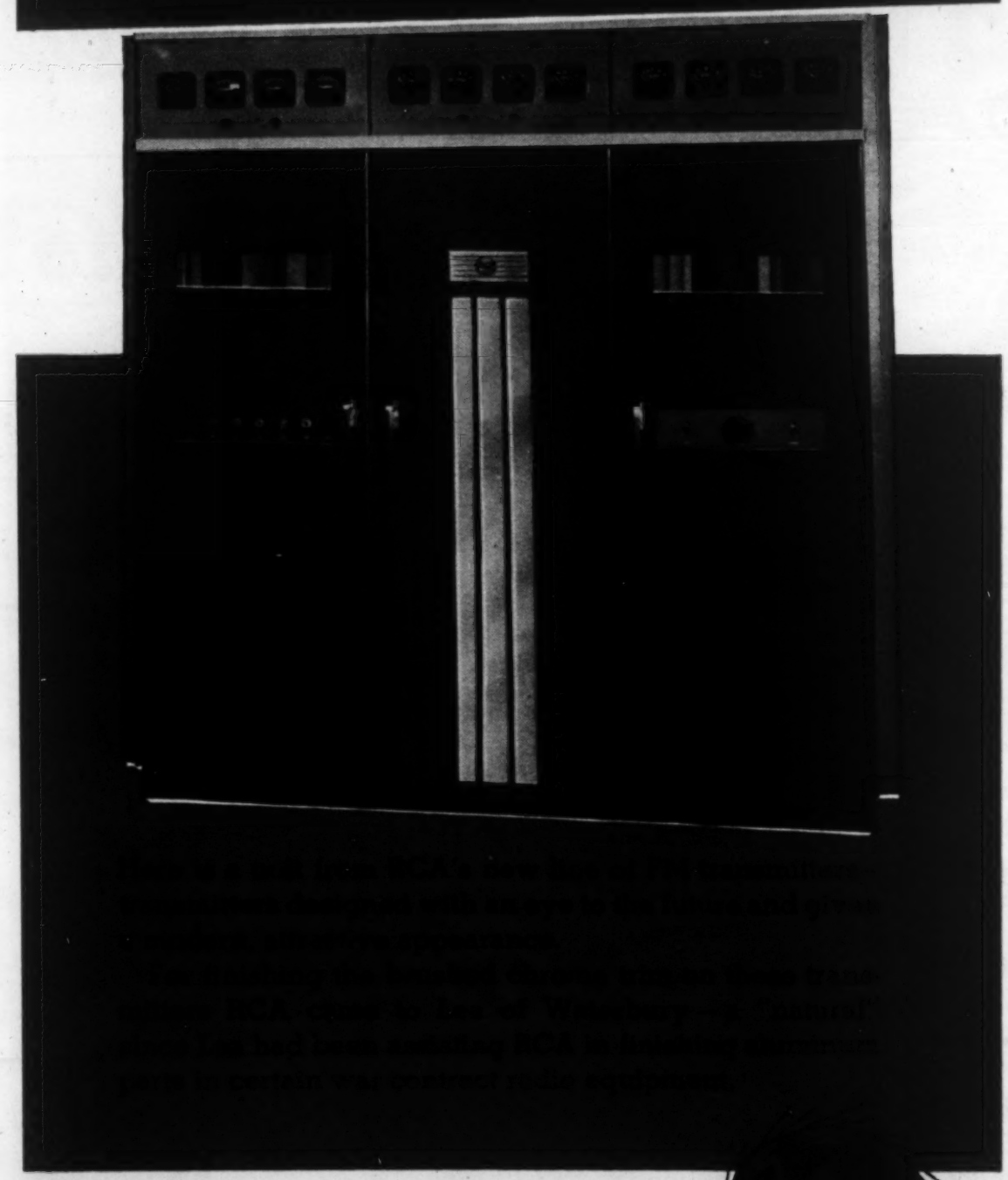
LEA METHOD
LEA COMPOUND

FINISH
BRUSHED CHROME
TRIM



Perhaps you, too, have a polishing, buffing or burring operation in your production line—if so, why not consult LEA? Our twenty odd years' experience in industrial finishing is your assurance that LEA Methods and LEA Compounds will help you cut costs, save time and improve the quality of your finishing.

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automatic program control, for heat cycles, or for completely automatic heat cycle program control.

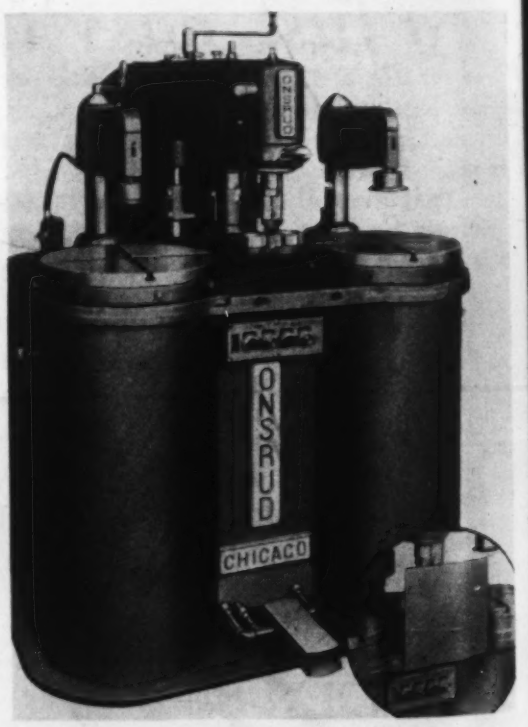
Because it is a portable unit, it is helpful, for example, in steel mills and heat treat shops, for the control of temperature of heating processes and set-up, and for experimental operations in the field, shop and laboratory.

The dimensions of this new instrument are 30 in. high, 24 in. wide, and 22 in. deep. It weighs 100 lb. In the welding field, it can be utilized with such equipment as induction heaters for preheating before and stress relieving after welding. It can also be utilized with other systems that employ resistance heating.

Contour Milling Machine Designed for Aluminum

Round, rectangular or irregularly contoured parts up to 18 in. in overall dia. can be produced in continuous operation on the new rotary table contour milling machine, developed by the *Onsrud Machine Works, Inc.*, 3900 Palmer St., Chicago 47. The milling machine is designed for the machining of aluminum and all other nonferrous metals with similar cutting characteristics.

The machine's uninterrupted production cycle is possible because of the dual-table construction which permits one of the tables to be loaded by the operator while work is



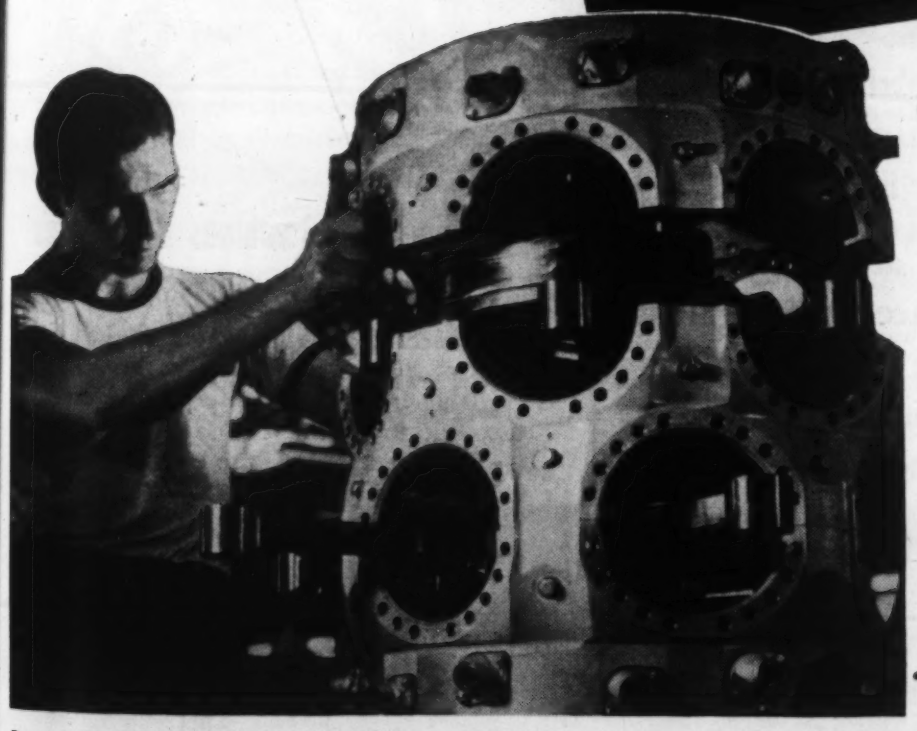
Designed for high production, this contour milling machine is suitable for aluminum and other nonferrous metals.

being milled on the other table. Thus, a second work piece is loaded and ready for completion of the first part with no time lost between machining cycles. As each milling operation is completed, the operator

Alloy Steels

Save Weight...

...because they can be used in thinner sections—without loss of strength and toughness



Because Republic Alloy Steels can be used in thinner sections to save weight—without any sacrifice of strength—the weight of this airplane engine crankcase was substantially reduced. Other advantages included lower overhaul costs and a 10-year record for reliability. Ask Republic metallurgists what alloy steels can do for your product.

There is no excuse for efficiency lost because working parts or tools are burdened with excess deadweight. Nor is there any reason for unnecessary bulkiness where streamlining is desirable. The high strength-to-weight ratio and wear-resistance of Republic Alloy Steels are proving both of those statements today in all types of machinery and tools.

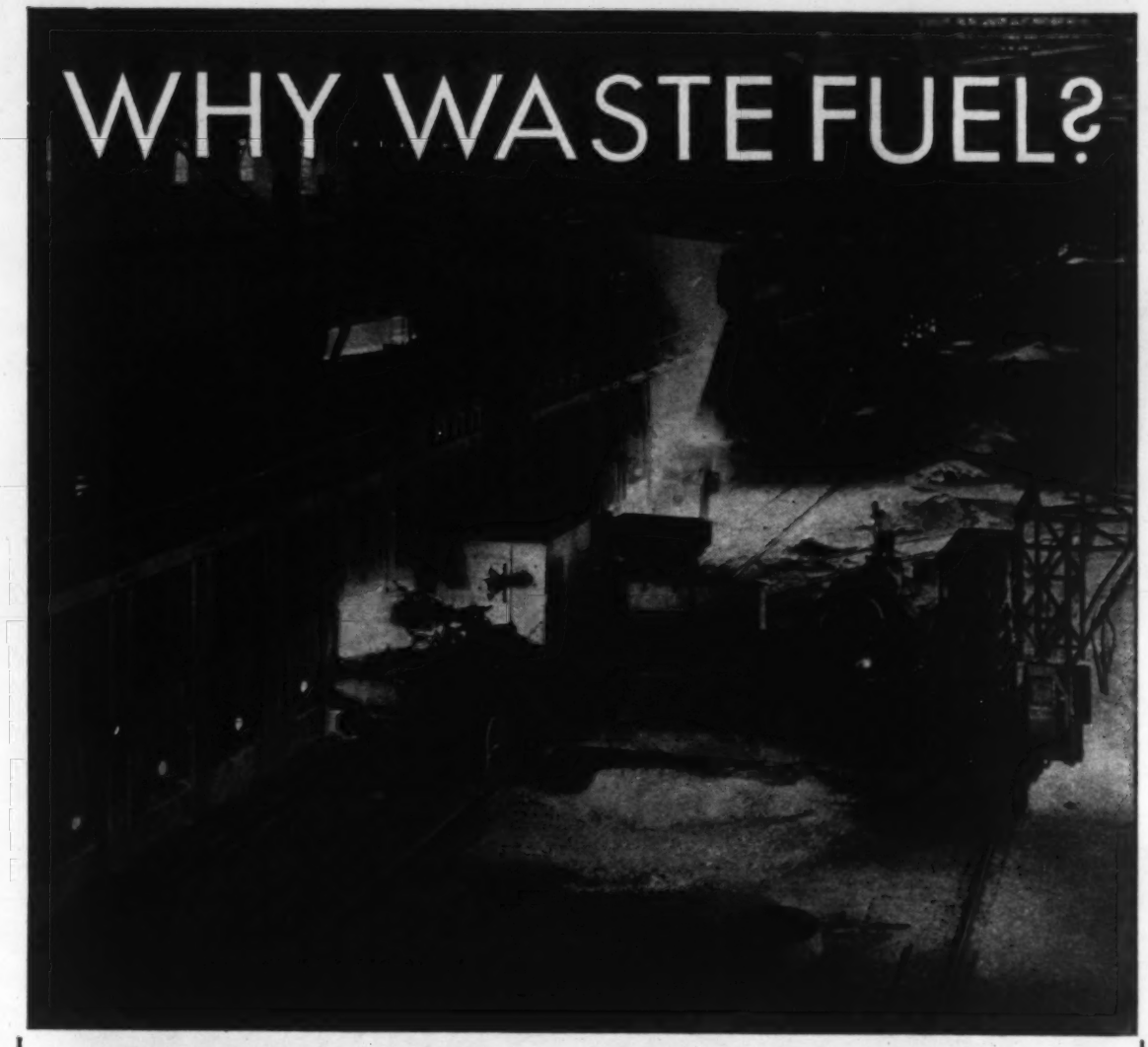
Because of the ideal combination of high strength, toughness and hardenability in these fine steels, it frequently is possible to reduce cross-sectional areas and bearing surfaces—without any loss in safety factor, service life or ultimate cost.

Republic—world leader in the alloy steel field—is well prepared to discuss the advantages of these steels as applied to *your* individual needs. Write us.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES, CLEVELAND 1, OHIO
Export Dept.: Chrysler Bldg., New York 17, N. Y.

Republic REPUBLIC STEEL REG. U.S. PAT. OFF.
ALLOY STEELS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing



Therm·O·flake *prevents waste*
BY REDUCING HEAT LOSSES...

MORE THAN 25% of Open Hearth fuel can be wasted through heat lost through brickwork and heat absorbed by cold infiltered air.

Therm·O·flake INSULATIONS are designed to reduce heat losses and seal furnace walls against cold air infiltration. These are used regularly on hundreds of open hearth furnaces and save steel producers thousands of fuel dollars daily.

Therm·O·flake ENGINEERS will prepare an accurate fuel economy survey of existing furnaces in your plant and submit complete thermal data and recommendations for safe maximum insulation of any open hearth furnace, on request.

Illinois Clay Products Company
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Exclusive Manufacturers of
Therm·O·flake
open hearth Insulation

presses a pedal which automatically disengages the driving clutch for the rotating table, engages the clutch for the waiting table, shifts the cutting tool to the new work.

The milling operation is completely automatic. Work is rotated on the tables past the cutter. The roller contacts the pattern under the work and guides the cutter; the guide roller is held to the pattern by pneumatic pressure. The work is held in place on the tables by means of air clamps designed to synchronize with the right to left travel of the overarm. The rollers are so designed that they can be adjusted in relation to the cutter to make up for the wear. A snubber absorbs the shock when the roller contacts the pattern.

● A chemical resin coating that is said to have no tendency to craze or burnish and having the added advantage of lessening the residual tack inherent in plasticized vinyl compositions has been developed by *Interchemical Corp.*, Finishes Div., 350 Fifth Ave., New York 1. Designed to meet a wide variety of production requirements, the finish, called Clear Topping, can be applied either by hand or by machine methods—and can be air brushed, knife spread or roller coated.

Machine Tool Combines Advantages of Shaper and Planer

A machine combining some of the advantages of both the shaper and the planer is available from the *Rockford Machine Tool Co.*, Rockford, Ill. It is said to be one of the first to employ the use of hydraulic pressure for the feeds as well as the table drive. The shaper-planer was formerly available only in an openside type.

Bed, columns and rail of this new machine tool, known as the Double Housing Hy-Draulic Shaper-Planer, are of heavy cross section to give rigidity under all working conditions. Its two columns provide maximum support to the crossrail tool heads, an essential in heavy-duty work.

It has design features such as dual controls for rail head and table, and can be supplied with two tool heads with automatic tool lifters for the crossrail and two side heads with automatic tool lifters. The second crossrail head and side heads are extra equipment. Shaper-Planer is built in three sizes: 24 by 24 in., 30 by 30 in., and 36 by 36 in. Stroke length sizes of 6, 8, 10 and 12 ft. are built in each size.

The openside shaper-planers are built in sizes 24 by 24 in., 24 by 36 in., 32 by 24 in., and 32 by 36 in.; five stroke length sizes ranging from 42 in. to 144 in. are built in each size.

Temperature Ranges Required for Pressure Vessels at BLACK, SIVALLS & BRYSON, Inc. Demonstrate Controllability of GAS

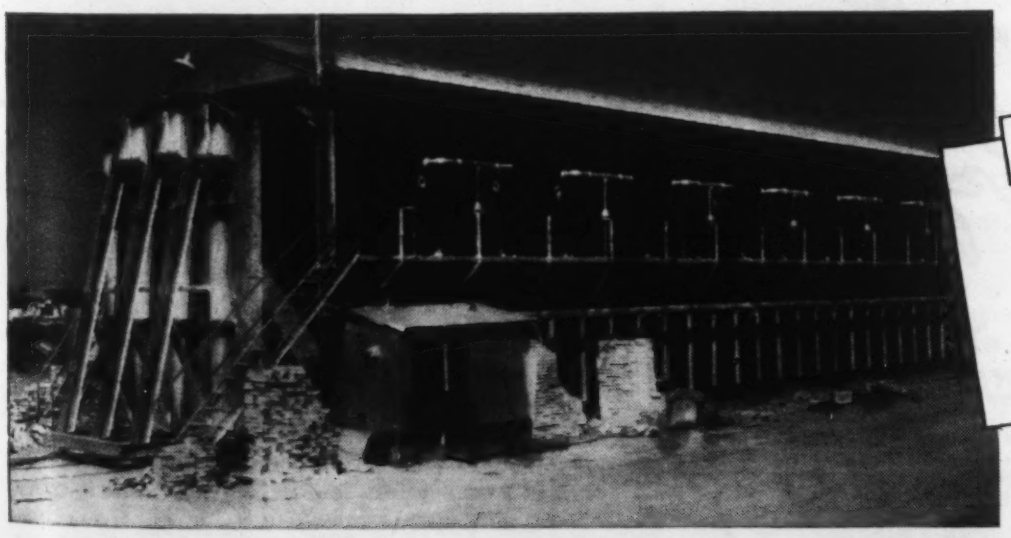
Safety codes govern many of the manufacturing and testing methods for pressure vessels. One of the most important processes, stress relieving, requires precise control of temperatures throughout the cycle—just the type of temperature control to be found in thousands of industrial applications of GAS for heat treating.

Specialists in the manufacture of pressure vessels depend on GAS for heat processing of all types. The pioneering firm of Black, Sivalls and Bryson, Inc., Kansas City, uses GAS in the manufacture of tanks, valves, pressure vessels and safety heads. President A. J. Smith says,

"Throughout the past 25 years we have depended on GAS to provide the exacting temperatures for our work. In many of our plants we have developed special GAS equipment; our large stress-relieving furnace at Oklahoma City is a typical example."

In this large furnace the GAS control system is arranged to provide temperatures up to 1200° F. for any time-cycle required. Automatic regulators and recording pyrometers assure maximum fuel efficiency while the flexibility of GAS is an important factor in maintaining production schedules on vital equipment.

Stress-relieving is just one of the applications of GAS for heat processing. You'll find hundreds of other uses for the productive flames of GAS—they're worth investigating.



MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

One of the largest stress-relieving ovens in the United States, this installation at Oklahoma City is 77' long, 12' wide, 18' high—Gas-fired and equipped with recording pyrometers.

AMERICAN GAS ASSOCIATION

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OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS.

"Miss Great Lakes" Gold Cup winner for '48

Depended on Wheelock, Lovejoy Alloy Steel

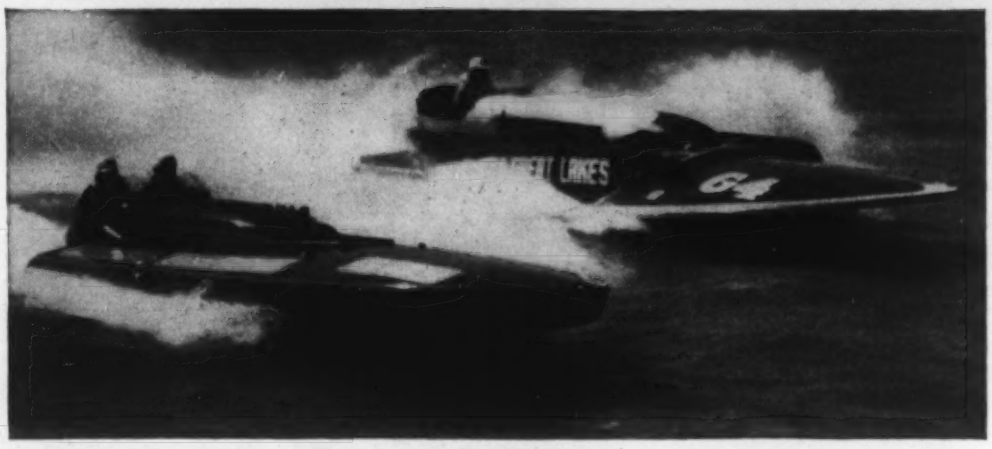

Photo Courtesy The Detroit News

UNUSUALLY ROUGH RACING CONDITIONS DISABLED 12 OUT OF 14 BOATS

Properly selected alloy steel, from which vital equipment was fabricated, played a leading role in winning the grueling 1948 Gold Cup race that saw only 2 of 14 starters cross the finish line. The winner, "MISS GREAT LAKES", driven by Danny Foster and owned by Al Fallon, had underwater struts, rudder, jack shaft and steering pitman arm made from Wheelock, Lovejoy HY-TEN B #3X steel. This particular alloy was selected and properly heat treated to meet the most rugged conditions possible. The fact that not one of these parts failed or even bent, in spite of the terrific beating they took, is ample proof of HY-TEN's superior physicals. And it's proof too that Wheelock, Lovejoy knows steel. Perhaps you have a tough job that demands just the right steel—write Wheelock, Lovejoy today.

WL *steels are metallurgically constant. This guarantees uniformity of chemistry, grain size, hardenability—thus eliminating costly changes in heat treating specifications.*

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

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HY-TEN and AISI

Flame Machining Process for Sprockets and Gears

A new method of flame cutting has been announced by the *Cogmatic Co.*, 757 N. Water St., Milwaukee, Wis. Sprockets are flame machined from steel plate in 5 min. for a 12-in. sprocket. Other cutting times vary, depending upon the diameter, thickness, and characteristics of the metal.

Employing a pantograph principle, an oxyacetylene cutting head assembly, mounted on a track, is moved forward and backward by mechanical linkage. Such movement is transmitted by following the contour of one of 20 basic cams, the design of which reflects standard and special sprockets and gears. This cutting head is led into the path of a revolving steel blank, whose turning rate is related to the speed of the cutting head.

A ⅓-h.p. motor with a variable speed control moves all parts. As each tooth is cut, four gradual accelerations and decelerations in amplitudes of 4 to 1 are required, and when cutting as many as 14 teeth per min., 56 speed variations are necessary. A speedometer is used to indicate the speed variations as they occur; this speed is controlled by means of an auxiliary cam which is so designed that the summations of circular and radial speed is constant.

Through combinations of cams, changes in the position of the pantograph legs, and substitutions of various standard size driving gears, more than 5000 types and sizes of sprockets and gears can be flame machined.

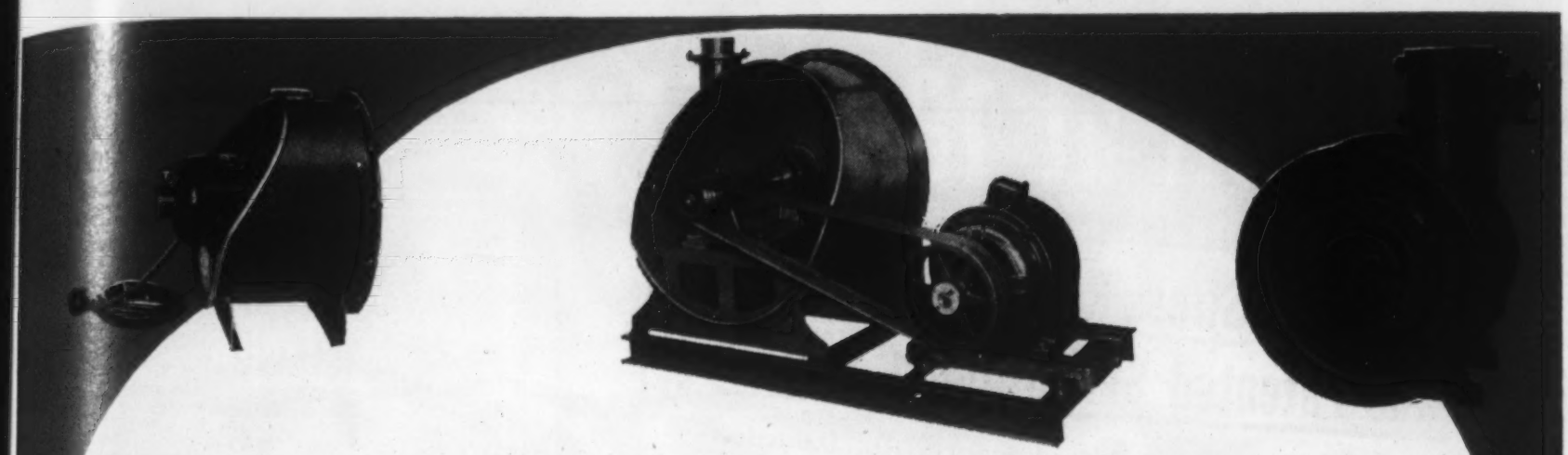
The present model will handle sprockets and gears with diameters up to 4 ft., but a new model now nearing completion will cut products over 5 ft. in dia. Blanks 3 in. thick have been cut, but present aims are to cut up to 6 in.

The basic dimensions of the steel table on which the machine is mounted are 33 in. high, 43 in. wide, and 69 in. long. The pantograph and cam tracing parts are mounted in the rear, the cutting head being forward.

Hardness Tester Has Lightweight Aluminum Body

A new hardness tester, 65 to 85 lb. lighter due to the fact that the body is cast in aluminum, is available from *Clark Instrument, Inc.*, 10200 Ford Rd., Dearborn, Mich. The tester is used for Rockwell testing of hard and soft steel, brass, aluminum, cast iron, copper, other metals, alloys, and plastics. Other features of the tester include a frictionless spindle said to assure a correct minor load; positive tripping for a more accurate major load; and an elevating screw fully enclosed for protection from dust, grit and rust.

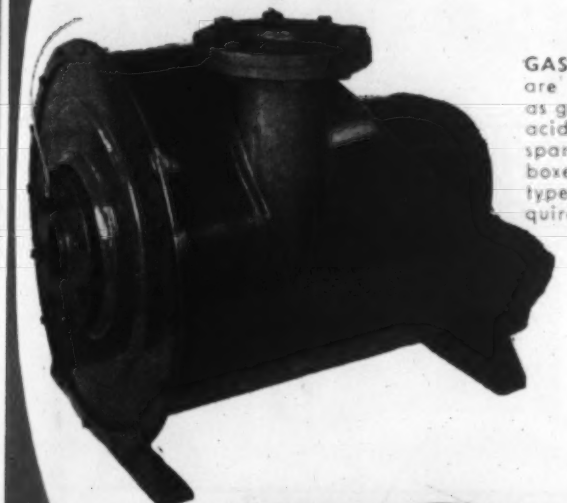
The frictionless spindle is designed to overcome the spindle's natural tendency to be forced off the true vertical path when the minor load is applied. The tester is also



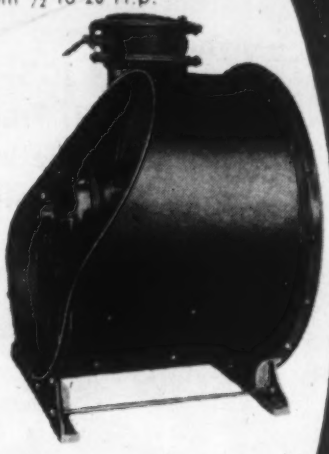
MIDGET: For individual air service the "Midget" is available featuring compactness, light weight and low cost. Built to deliver pressures from 12 oz. to 2 lbs. Motors from 1/3 to 2 H.P. and volume up to 75 cfm. Equipped with universal motors not recommended for continuous service.

BELT DRIVE: For 25 cycle or gasoline engine drive the belt driven unit is offered for continuous service and a large range of capacities. 1/3 to 50 H.p. and up to 5 lbs. pressure.

SINGLE STAGE: For medium and light duty service, the single stage unit provides efficient and reliable service at low first cost. Pressures from 4 to 16 oz.; capacities from 1/2 to 20 H.p.



GAS BOOSTER: Gas tight turbos are available in most sizes. Used as gas boosters, and for exhausting acid and poisonous fumes. Non-sparking metals, special packing boxes, overhung or four bearing types, designed for individual requirements.



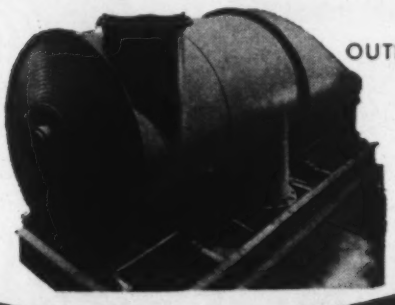
MULTI-STAGE: For heavy duty service larger capacities and higher pressure. Two types; slow speed 1750 r.p.m. and high speed, 3500 r.p.m. High efficiencies, quiet operation, long life. Capacities up to 20,000 c.f.m. and 5 lbs. pressure.

The multi-stage Turbo-compressor is recommended for all applications requiring the best. Assures long life, low maintenance and reliable service.

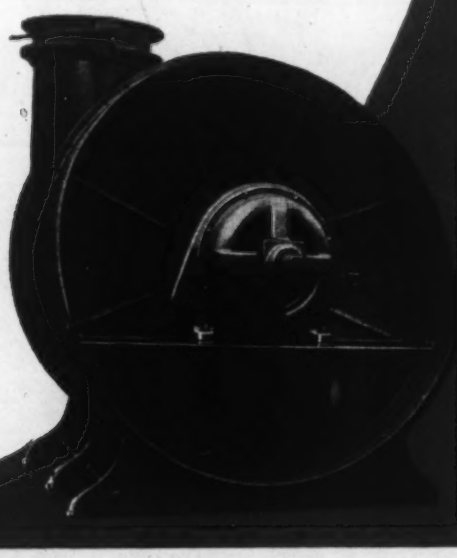
OVERHUNG

4 BEARING: Two types are offered for installations with coupled drive by motors with standard shafts.

Accurate alignment of these blowers is necessary for satisfactory operation, and with the Spencer design this can be easily maintained.



OUTBOARD

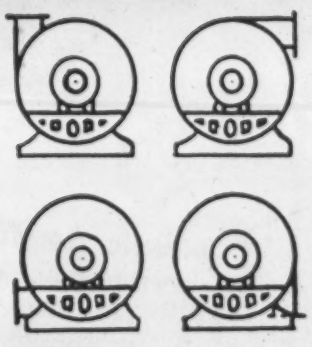


Spencer centrifugal type Turbo-compressors are regularly used for supplying low pressure air for oil and gas-fired furnaces, foundry cupolas, pneumatic conveyors, agitation of liquids and blowing or exhausting for many different applications. Spencer Turbo-compressors deliver air at varying volumes with a uniform pressure which eliminates the necessity of any adjustment of the blast gate at each change of load.

MECHANICAL ADVANTAGES

Simple Construction
Lightweight Impellers
Wide Clearances
Large Shafts
Ball Bearings
One Piece Casing

Spencer Bulletins are available as follows: Data Book No. 107, Gas Boosters No. 109, Four-Bearing No. 110, Blast Gates, No. 122, Foundry No. 112. Descriptive Bulletin 127 and Technical Bulletin 126



The discharge may be in any one of four positions on any Spencer Turbo Compressor.

359-E

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONN.

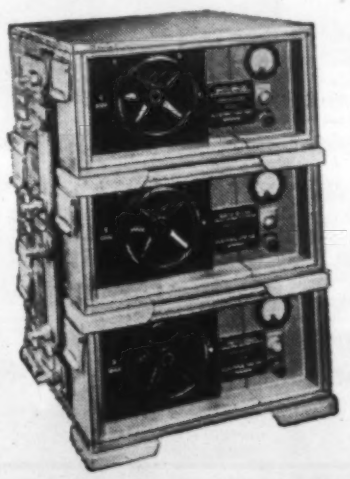
SPENCER HARTFORD

TURBO-COMPRESSORS

A CINCH at 1800° F.

Preheating and Stress Relieving for Welding -by the Patented Smith-Dolan System

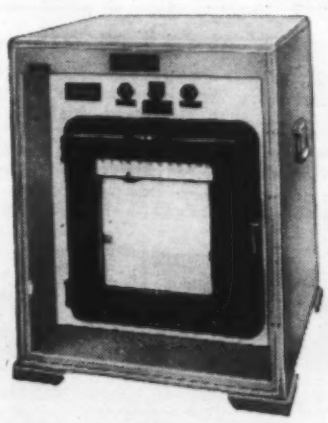
■ It's an accomplished fact that Electric Arc Induction Heaters, through the patented Smith-Dolan System, can generate heat to 1550° F and 1850° F on both chrome molybdenum and stainless steel. Here is equipment for ANY TYPE OF JOB—equipment that can be *purchased outright* or *rented*. From what other source could you possibly obtain such wide latitude in planning for every job, every problem in preheating and stress relieving before welding?



NEW MODEL U-P, Smith - Dolan System, portable, low frequency induction heater, three-high stack shown, 30 kva, 10 kva per unit.

Buy one or stack two or three for increased capacity.

Buy what you need—build as you go.



AUTOMATIC CONTROL CABINET

Used with Model U-P units (shown) and Model GC Duplex 120 or 150 kva induction heaters (shown in catalog).

MODEL BH, Smith-Dolan Induction Heater (mobile type) complete with self contained control instruments.

Electric Arc Induction Heating Equipment can be broken down to manual control, semi-automatic program control and fully automatic heat cycle program control. Operators find this equipment easy to use in field or shop, time saving and guaranteed to produce thorough penetration in heating large and heavy wall weldments. Today, more than ever, Electric Arc equipment is specified where other methods are too costly and impractical. Write for informative catalog.

ELECTRIC-ARC INC.

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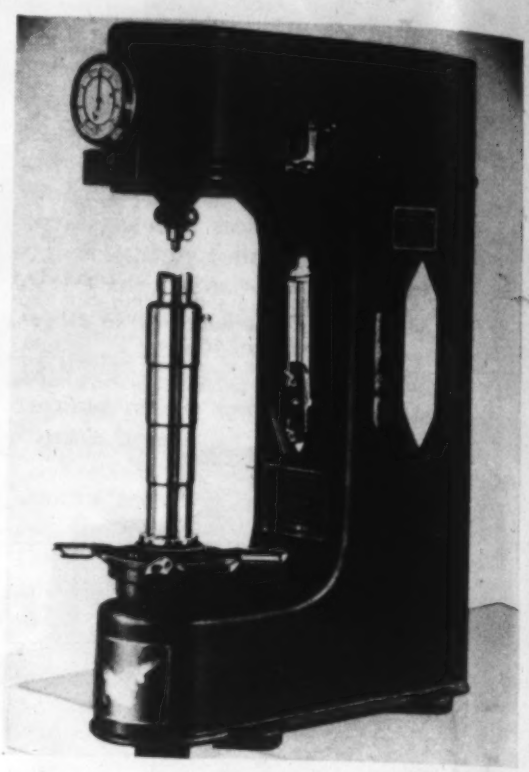
WELDING EQUIPMENT, ELECTRODES & SUPPLIES

said to overcome the danger of an incorrect major load, sometimes caused by friction or drag of the tripping lever on the loading beam. This hazard is eliminated by a zero drag tripping lever, on which tripping is positive and the weight always falls free.



This new hardness tester features light weight and high accuracy.

The elevating screw on the tester is enclosed from top to bottom, with the lower part serving as an oil reservoir. The lock screw that holds the telescope cover to the elevating screw is easily loosened to permit lowering of the cover.

These hardness testers are available in three standard models, with 8-, 12- or 16-in. vertical capacity.

Mechanical Separator Is an Aid in Tumbling Operations

A new mechanical separator for use with tumbling equipment has been announced by the *Sturgis Products Co.*, Sturgis, Mich. The separator is a motor-driven unit for removing parts from chips or separating mixed chips into the various sizes.

The new separator consists of a welded steel frame with an inclined surface on which is located a hoist pan serving as a hopper; and a waist-high separating table which supports a mechanized shaker screen assembly. The inclined surface for the hoist pan support is adjustable for correct gravity flow of parts and chips onto the screen.

The shaker screen assembly can be elevated from a horizontal to an inclined position with a height of 4 in. on the end nearest the hoist pan. This height, plus the reciprocating motion provided by the motor drive, separates parts from chips and automatically discharges the former at the oppo-

For Devotional Statuary and Figurettes

Plastic Surpasses Plaster

Plastic is Practical

Sculptures shown are injection molded of structurally strong acetate and are insured by replacement guarantees against chipping and breakage.

Plastic is Preferable

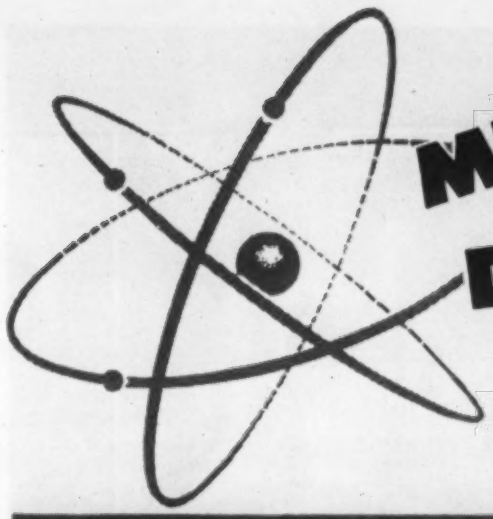
Every detail of the sculptor's original art is faithfully and expressively preserved thru proper mold design, mold construction and processing.

Plastic is Popular

Its use, here too, bespeaks dignity, quality; possesses maximum appeal; exemplifies the type of custom craftsmanship you can look for when you look to Consolidated. Inquiries invited!

Your Blueprint in Plastic

CMP



MIRACLES DO HAPPEN !

WITH

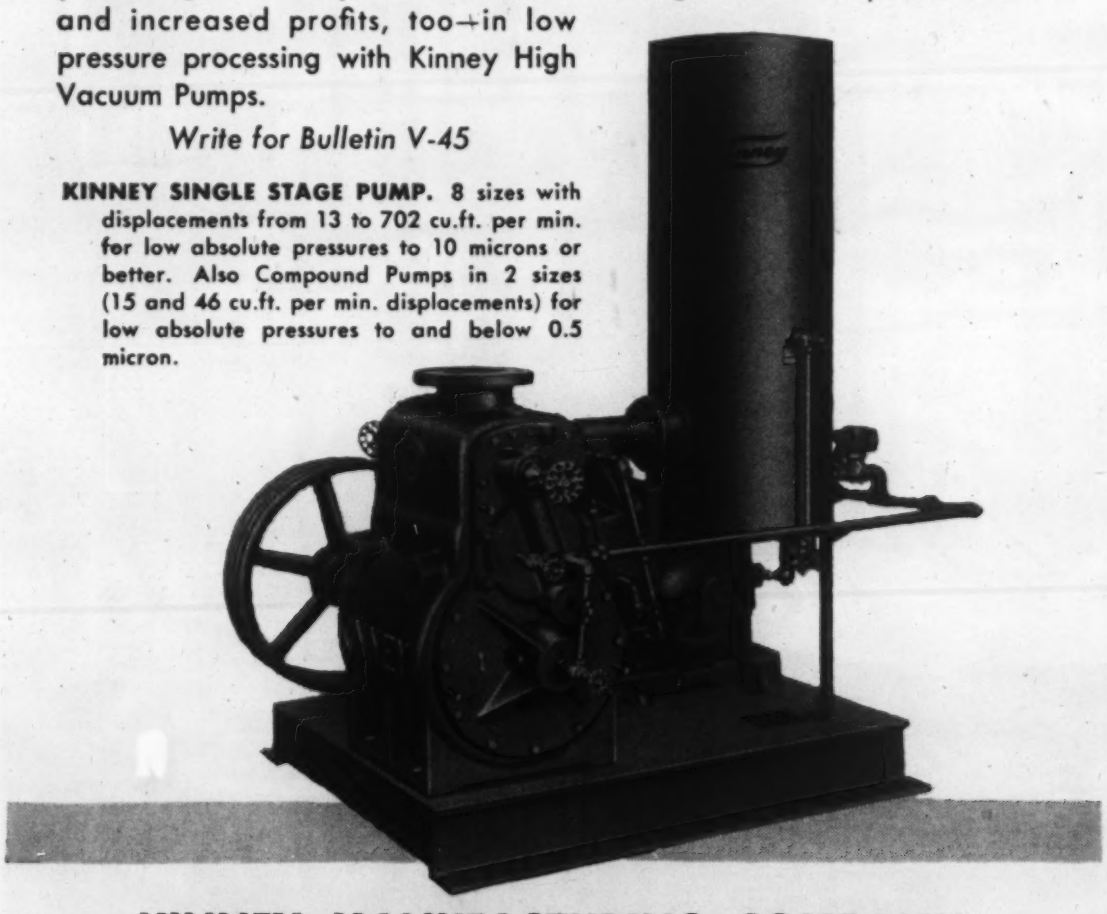
KINNEY

HIGH VACUUM PUMPS

Kinney High Vacuum Pumps are performing modern-day miracles in industrial production. Already they have greatly improved countless products and have made possible many spectacular new developments. Further miracles continue to unfold almost daily. Kinney Pumps are playing a vital part in producing pharmaceuticals, dehydrating foods, coating lenses, sintering metals, exhausting lamps and tubes, and performing many other low pressure operations. The high pumping speed, long life, and dependability of Kinney High Vacuum Pumps have indeed put vacuum processing on a full production basis. Investigate the new possibilities—and increased profits, too—in low pressure processing with Kinney High Vacuum Pumps.

Write for Bulletin V-45

KINNEY SINGLE STAGE PUMP. 8 sizes with displacements from 13 to 702 cu.ft. per min. for low absolute pressures to 10 microns or better. Also Compound Pumps in 2 sizes (15 and 46 cu.ft. per min. displacements) for low absolute pressures to and below 0.5 micron.



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site end. The screen assembly is tapered at the discharge end and is provided with a vertical lift gate so that the parts do not leave the screen before the separation is complete.

The stroke of the screen assembly can be changed, by means of a variable adjustment on the motor drive, to provide varying amounts of agitation, depending upon the requirements of the separation. The separator is equipped with a detachable tote pan shelf.

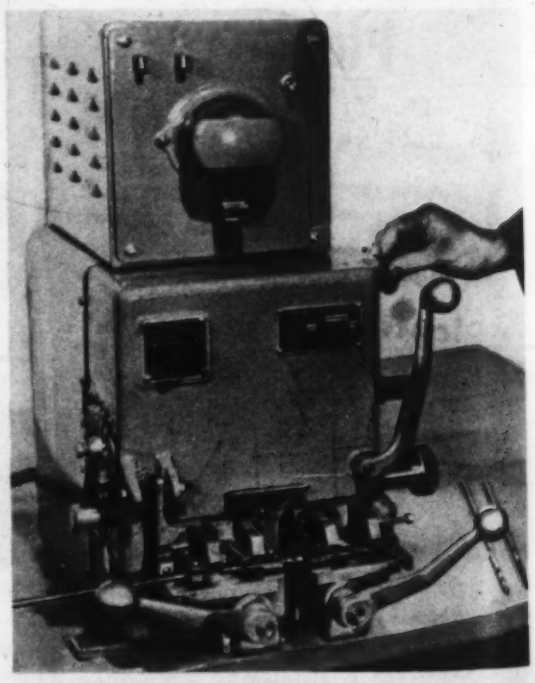
Motor drive can be either a 110 or 220-440 v., 3 phase, 60 cycle, geared-head ¾ h.p. electric motor with control switch.

Flash Welder Welds Saw Bands, Wire and Rods

A new production flash welder that will join band saw blades up to 2 in. in width has been announced by the *DoAll Co.*, 254 N. Laurel Ave., Des Plaines, Ill. This unit, equipped with special inserts, will also join wire, drill rod, bars, flat stock, etc. up to 5/16 in. in dia., making it useful for salvaging broken tools, welding extensions on drills, reamers, taps, grinding wheels, etc.; joining coils or rings; and for numerous other repair jobs and tool room or production applications.

The welder not only welds but also prepares the material for welding, anneals, and cleans up the weld.

The unit is equipped with a grinding unit for preparing material to be welded



An extension being welded onto a drill by the new flash welder.

and to grind off flash after welding. A saw thickness gage is included on the grinding unit for dressing the weld to proper thickness. The welder will perform etching operations when an etching pencil is connected to the welding jaw. Thus, permanent marking or numbering of tools, dies, parts, etc.,

Another LATROBE first!

Designed for Intermediate Service

... where the full properties of the more costly higher alloy high speed steels are not required!

This new **ELECTRITE MV** family of high speed steels is the product of years of research by Latrobe Electric Steel Co. metallurgists. Developed specifically to fill the need for Intermediate Alloy High Speed Steels, the **MV** family is suitable for uses where higher alloys are not required.

The introduction of these new steels marks another step forward in Latrobe's continuing efforts to produce for Industry better steels for better tools at lower cost.

These intermediate high speed steels are recommended for small drills and reamers, thread chasers, taps, pipe taps, etc., wood-working knives and cutters and for body stock for carbide-tipped drills and reamers. Our sales engineers will be glad to assist you in selecting the proper grade for your particular applications.

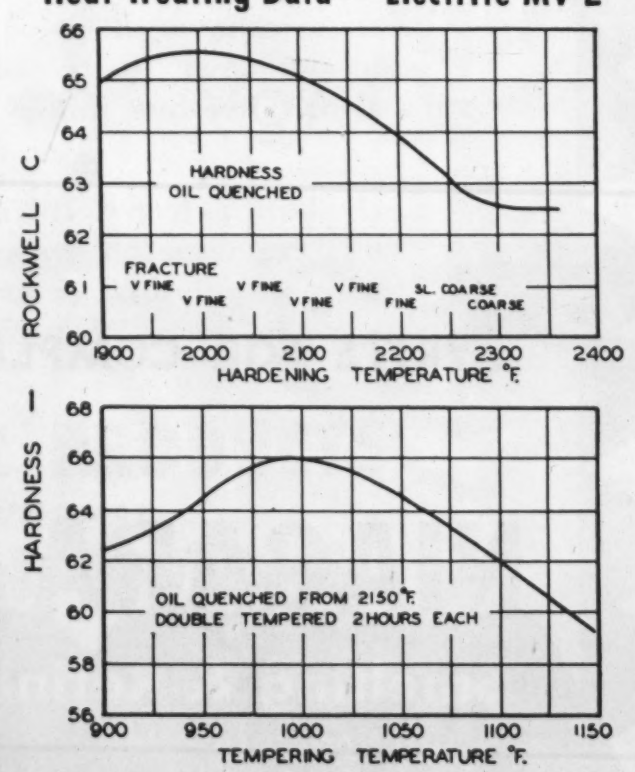
LATROBE ELECTRIC STEEL CO., Latrobe, Pa.

MM-6

TYPICAL ANALYSES	C	Cr	Mo	Va
MV-1	.80	4.10	4.25	1.10
MV-2	.88	4.10	4.25	2.00
MV-3	1.18	4.10	4.25	3.15
MV-4	1.40	4.10	4.25	4.15

Shown at right are hardening and tempering curves of MV-2 grade.

Heat Treating Data — Electrite MV-2



"FALLS BRAND" ALLOYS
AMERICA'S LARGEST PRODUCERS OF ALLOYS

"FALLS" COPPER SHOT

for Addition to Cast Iron

Promotes the following properties:

- Increased tensile strength, transverse strength and Brinell hardness.
- Increased wear resistance—increased resistance to heat and corrosion.
- Increased fluidity and sharper castings.

WRITE FOR COMPLETE DETAILS.

NIAGARA FALLS
Smelting & Refining Division
Continental-United Industries Co., Inc.
BUFFALO 17, NEW YORK

can be made conveniently for identification purposes.

A lighter duty butt welder with capacity for welding saw blades up to ⅜ in. in width is also available for either bench or pedestal mounting.

Measuring Microscope Designed for Shop Use

A new measuring microscope for use in the mold shop and in the toolroom has been announced by the *Boeckeler Instrument Co.*, Tucson, Ariz. This instrument is said to be new in concept and is offered as a machine to be used in the toolroom.

Its design differs from the conventional lead screw type, and has a nominal range of 10 in. Objects up to 7 in. high are accepted under microscope objective. The micrometer head is provided with a scale on barrel, which can be tilted to correct for any lead screw error. Consequently, any residual lead error of this screw is exactly cancelled. The instrument is built to accept large and heavy workpieces for measurement, and is proving successful in measurement of dies and molds.

The microscope has 32X power magnification, and higher powered objectives and eyepieces can be added. The base is stress relieved and pre-aged Meehanite. Gage rods are hardened, ground, carbide tipped and lapped to a tolerance of 0.000025 in. The stage moves on precision ball bearings, and is provided with V channels for measurement of screws, taps, diameters of small parts, etc.

It is possible to use the machine as a layout device. Hole locating lines can be put down with more accuracy than is possible with a height gage. It is then possible, by use of a spindle microscope, to sink holes, etc. with jig bore accuracy.

Magnaflux Unit Shows Defects in Any Direction

Magnetizing parts in several directions at the same time is possible in a new line of magnetic particle inspection units developed by *Magnaflux Corp.*, 5900 Northwest Highway, Chicago. This method permits parts to be inspected for defects in any direction with one magnetizing operation and one visual inspection operation instead of the usual two or more magnetizations and inspections which have been required in the past.

(Continued on page 146)

There may be some "wonder metallurgical cure-all" for every parts headache.

There may be—but Moraine Products doesn't pretend to manufacture it.

For, while we are proud of our achievements in powder metallurgy, we also admit its limitations. Our broad manufacturing experience has taught us that powder metallurgy should be recommended with care.

It is part of this realistic approach to tell manufacturers that powder metallurgy is practical for their parts only when specific requirements of shape and physical properties are attainable. We also make it our policy to emphasize its impracticability for small run, job-lot orders where the tooling and setup costs are out of proportion.

Perhaps this straightforward attitude is why the customers we do serve acclaim metal powder parts by Moraine as "just what the doctor ordered."

MORAINE PRODUCTS
DIVISION OF
GENERAL MOTORS
DAYTON, OHIO

Centrifugally-cast Ampco Metal valve-seat inserts are quality features of the 61 and 74 cu. in. O.H.V. engines on the famous Harley-Davidson motorcycles.

Durable Ampco Metal gets the hot seat . . .

–because it has the wear-resistance to "take it" on the toughest jobs

When a famous motorcycle manufacturer specifies Ampco Metal for valve-seat inserts *he knows his customers are getting a "plus" value.* And that value is featured by the manufacturer in advertising literature as an important sales appeal!

That's logical when you consider the long life and trouble-free service you gain, when critical parts are made of Ampco metal—with its outstanding resistance to corrosion, compression, impact, fatigue, and wear. It has excellent bearing qualities, too, plus unique efficiency at extreme temperatures.

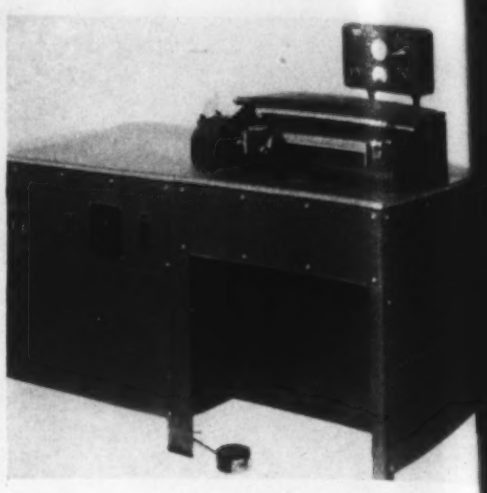
Call your nearby Ampco engineer for full information on Ampco Metal and Ampcoloys . . . available in castings, extrusions, sheet, forgings, and fabricated assemblies. *Write for latest literature.*

Ampco Metal, Inc.

Department MM-11 • Milwaukee 4, Wisconsin

Field offices in principal cities

The new system comprises the application of two magnetizing forces simultaneously. The parts are placed between the heads on the unit, where they receive magnetization in both directions during one shot while the inspection bath is being applied.



One of the new line of magnetic particle inspection units which magnetize parts in several directions at the same time.

The type MV is one typical unit of this new type. In it, a current is passed through the part as in normal circular magnetization. At the same time the part is subjected to a longitudinal field of regularly changing strength. The resultant varying magnetizing force swings through an angle within the piece of considerably more than 90 deg., and thus cuts across all possible defects at right angles.

In these units the swing of the field may be adjusted from 0 deg. swing to well over 90 deg., by changing the relation of values between the circular and longitudinal magnetizing fields. This type of magnetization is used with the fluorescent Magnaglo particles as well as the usual wet Magnaflux visible particles to obtain indications of defects in the parts.

Inspection with the new system is at present most applicable to the smaller parts which are substantially uniform in cross-section and are of essentially cylindrical or bar shape. This includes many parts made and inspected in high volume such as bolts, wrist pins, roller bearings, small gears, camshafts, etc.

● A new plater's computer has been developed by the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J. The computor determines, among other things, plating time required to deposit a given thickness of any metal, current density required to produce a deposit of given thickness, thickness of deposit resulting from an established plating time at a known current density, usual cathode efficiencies of all modern electroplating solutions and temperature conversion scale, degrees Fahrenheit — degrees Centigrade. The computer measures only 6¼ by 1½ in., and comes in vinyl carrying case.

Baldwin Watches Pouring Temperatures

Every foundryman knows that correct pouring temperature means better castings and increased production. In the foundries of the Baldwin Locomotive Works measuring these important temperatures has been made easy by a number of Brown *ElectroniK* Pyrometer installations.

The Brown system makes use of the *ElectroniK* indicating and recording instrument and a portable molten metal thermocouple. To make a measurement, the thermocouple is immersed several inches below the surface of the metal in the ladle. The instrument pointer then swings to the proper reading, which is readily visible on the large 28″ scale. The chart record is evidence of the stabilized reading. The entire measuring operation requires less than a minute of time.

The complete system for pouring temperature measurement has been field proved in many foundries where its use has resulted in increased production of higher quality castings, and longer furnace life. It will bring you all the advantages of uniform temperatures with the speed and convenience necessary in modern foundry operations. For complete information write for Data Sheet 5.4-2 and Catalog 15-13.

THE BROWN INSTRUMENT CO., 4517 WAYNE AVE., PHILA. 44, PA.
DIV. OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Offices in principal cities of the United States, Canada and throughout the world.

One of the Brown *ElectroniK* Pyrometer installations at The Baldwin Locomotive Works. The elevated location of the instrument permits an unobstructed view from any position on the floor.

BROWN *Advanced Instrumentation* **FOR BETTER PROCESSING** MINNEAPOLIS **Honeywell**

5 Kennamatic tools in action, roughing a forged steel stem pinion, SAE 5140. Speed is 230 SFM, feed .027", depth of cut 3/16" . . . and the Kennamatic tools turn out 350 pieces per index, 56,000 pieces per tool!

Another typical example of time-saving Kennamatic tooling. This cast iron valve body is turned at 250 SFM, with a feed of .005", depth of cut from 1/8" to 3/16". On this job other brazed tools had to be changed 8 times per shift . . . whereas Kennamatic inserts are simply indexed twice per shift, and give four days' service before re-sharpening.

When the going gets tough . . . . Kennametal Tooling is the sure way to faster production at less cost

Why wait for the going to get tough?

Under the pressure of rising costs—it becomes "tougher" and "tougher" to produce at a profit, and sell at a price.

But remember that "tough" is a relative term—any job is tough if there's an easier, faster, less expensive way to do it.

Your machining operations are tough, slow, and expensive . . . unless you are using uniformly strong, hard, long-lived Kennametal coupled with the latest Kennametal improvements in carbide tool design.

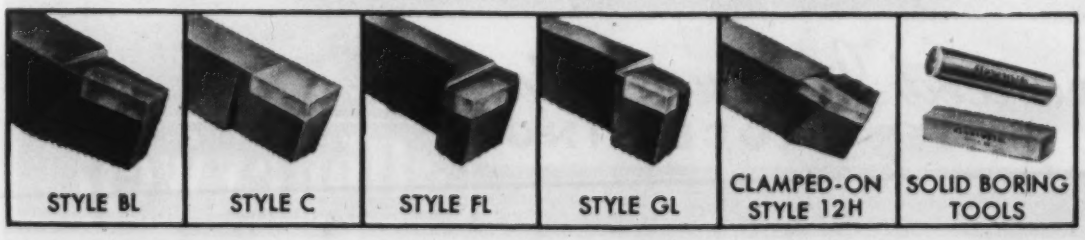
Kennametal tooling keeps your machines on the job with minimum interruption—enabling you to turn out from 2 to5 times more than steel tools on the same machine in the same time, with from 5 to 20 times longer tool life.

Use this modern tooling technique to save money in your plant—ask our district tool engineer to demonstrate.

Write for new Catalog 48.

KENNAMETAL Inc. Latrobe, Pa.®

MANUFACTURERS OF SUPERIOR CEMENTED CARBIDES AND CUTTING TOOLS THAT INCREASE PRODUCTION



New Micrometer Uses Dead-Weight Principle

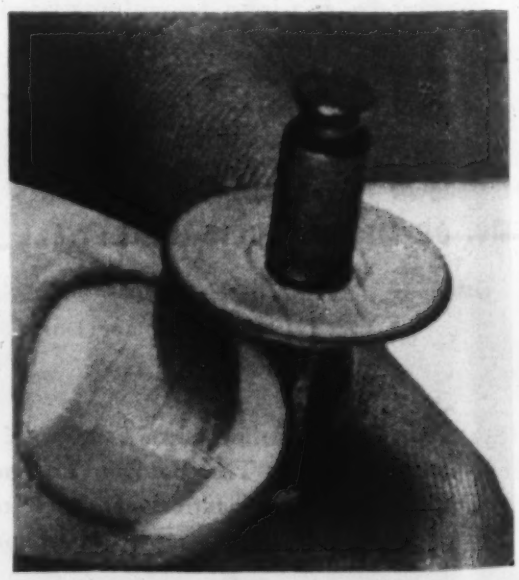
The new micrometer produced by the *E. J. Cady & Co.*, 132 N. La Salle St., Chicago 2, calipers thicknesses of sheet materials or other articles up to ½ in. It is suitable for thickness measurement for steel, plastics, papers, boards, mica, felt, glass, foils, aluminum, or any sheet stocks that have thicknesses within its range of operation.

The dead weight principle employs devices to maintain uniform measuring pressure at all times, at any point of anvil travel, whether the article measured is thick or thin. The top lever lifts the anvil. It descends by gravity, a dash-pot action preventing too-rapid descent. The pressure per sq. in. meets ASTM and TAPPI standards.

This instrument is provided with zero adjusting devices, accessible from outside the frame, permitting the indicator to be set at exact zero on the dial. Internally, the mechanism is designed to prevent an accidental change of this zero adjustment and maintain perfect alignment of working parts. The dial is 6 in. in dia. (thousandths or half-thousandths of an in. graduations), glass covered, and located for convenient reading.

New Rivet Has Large Bearing Surface for Blind Fastening Uses

A large, flat-headed rivet first developed by *Cherry Rivet Co.*, 231 Winston St., Los Angeles 13, for aircraft use is now being applied to truck and trailer fields to install plywood inner liners in trailers, vans, and truck bodies.



Close-up of the blind rivet for fastening cloth, wood, plastic and rubber to metal.

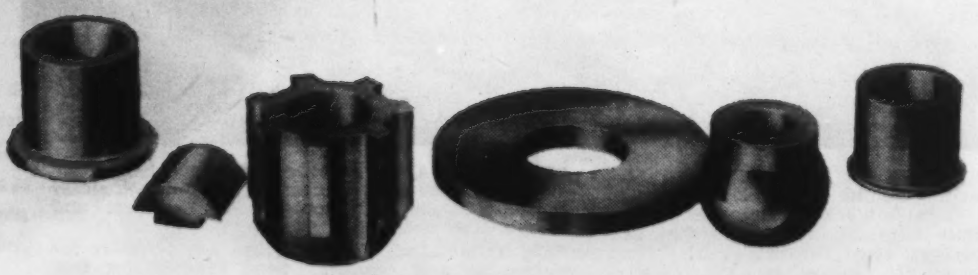
The large head gives this rivet-design ample bearing area to prevent the material tearing out or being crushed where cloth, wood, plastic, and rubber sheeting is being fastened to the metal framework. The rivet is installed by inserting it into pre-drilled

gramix gears

help this mechanical counter run for years without a miss!

The Silver King Mechanical Counter manufactured by The Production Instrument Co., of Chicago, meets the exacting requirements of industry for accuracy and dependability. It keeps right on counting, year after year, without a miss. Two good reasons why this practical counter *operates without maintenance* are the two Gramix Gears that form the heart of the machine. They are roughly equivalent to the transmission on a car. Not only do they do their appointed job unfailingly, but *their original cost is but a fraction* of that of the machined parts formerly used in the instrument. Gramix parts are precision-pressed from powdered metals and require no costly machining and hand finishing. The lubrication is impregnated right into the processed metal and never needs additional oil. Gramix powdered metal bearings, bushings, gears and machine parts *can be made in any practical size and shape.* Perhaps we can show how Gramix can help you maintain the dependability of your product and at the same time greatly reduce your cost of manufacture. Send us your prints for specific recommendations and ask for the 264 page Gramix catalog.

gramix

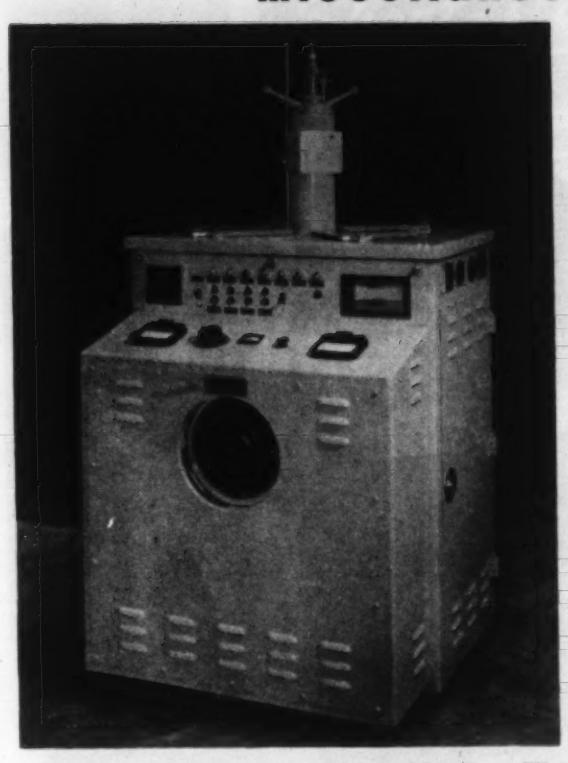


THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

Greater Flexibility

in examination of metals and miscellaneous materials by

X-ray Diffraction



afforded by the Hilger Research X-Ray Diffraction Unit. The HRX Unit is built around a 4 window hot filament demountable X-ray tube which has the following advantages:

1. Exposures using 2, 3 or even 4 different radiations can be taken on the same unit simultaneously.

2. The radiation at each window can be changed independently of the others in a matter of seconds without breaking the vacuum or affecting the alignment of cameras.

3. Increased intensities, made possible by heavier current than is practical with sealed tubes, reduce exposure times.

4. Replacements are limited to inexpensive filament and target nose caps.

The HRX Unit will be available for examination during October and November in New York, Boston, Detroit and Chicago. Write for more information if you are interested.

Ask for Hilger catalog 304/1

HILGER & WATTS, LIMITED • LONDON, ENGLAND

United States representatives:

JARRELL-ASH CO. • 165 Newbury Street • Boston 16, Mass.

EBONOL

blackening processes

FOR STEEL . . . COPPER . . . BRASS . . . ZINC

EBONOL-C. (U. S. Patent 2,364,993) This is the best method of blackening and coloring copper and its alloys. Durable black cupric oxide is produced in a simple solution. Any metal that can be copper plated can also take this finish.

EBONOL-S. A one-bath method of blackening steel. Temperature 285 to 290° F. Simple to use and pleasant to run.

EBONOL-Z. A simple process for blackening zinc plate and zinc base diecastings. Beautiful glossy or dull finishes are achieved at low cost and trouble-free operation.

NEW TUMBLING TECHNIQUES are available for blackening and coloring. Send samples for free finishing demonstrations together with advice of experienced research chemists. **Write for new literature with procedures.**

ENTHONE INC. • 442 Elm Street, New Haven, Conn.

holes. A hand or power-operated tool pulls the stem through the rivet shank, clinching the covering material and expanding the rivet into the framework. The rivet (type CR148) is available in four diameters . . . ⅛ in., 3/16 in., 5/32 in., and ¼ in.

Infra Red Units Improved for Greater Flexibility

New improvements in the design and construction of 6-, 8- and 12-lamp infra red portable electric units have been announced by *Carbomatic Corp.*, 24-81 47th St., Long Island City 3, N. Y.

One of the improvements is the steel welded stand designed to give rigid support to the reflector box and to allow greater flexibility in use—whether the units are employed singly or as a battery to form banks, tunnels, etc. Greater accuracy and stability are said to be afforded in the positioning of the units for heat-processing applications such as drying, including paint drying, baking, dehydrating, heating or pre-heating, thawing, warming and softening.

The aluminum reflector box is equipped with improved new lamps, resistant to sudden heat changes and to moisture. These infra red lamps, which are of the 125W, 250W, R-40 or 375W reflector-type, are devised to ensure safer operation and uninterrupted production for the user. Another feature is the steel tray, which is an integral part of the stand and is suited for use in the processing of small objects.

New Welder Features Four-Coil Transformer

A new a.c. welder, in models for both shop and industrial use, has been announced by the *National Cylinder Gas Co.*, 840 N. Michigan Ave., Chicago, Ill.

The welder is made in 12 models, of which seven are for high-speed, heavy-duty fabrication, and five are for duty in garages, repair shops, machine shops, mills, welding shops, and wherever light production work is carried on.

Among the advantages found in the models are a four-coil transformer with movable magnetic shunt, which is said to give fine welding characteristics at every point within the output range; and correct ratio of open circuit to arc voltage for faster burn-off, proper penetration, and correct breakdown of alloy rods.

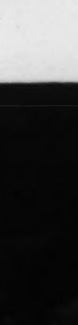
On both industrial and shop models, high potential secondary circuits give ample dielectric strength, tested to withstand 7,000 v.

A stepless full range output control is provided which gives the precise welding

Insert the rivets in the drilled holes. With the gun, pull through the rivet stem and expand the rivet in the materials to be fastened.

Cherry Rivet fastening technique helps keep this floor furnace assembly line in steady production.

Cherry Blind Rivets



MAKE THE HARD JOBS EASY

ELIMINATES BOTTLENECKS No reason to worry about fastening problems with bends, tubes, or tight angles. Cherry Rivets conform as well to curved surfaces as to flat surfaces. Highly adaptable to production-type assembly work in many fields—marine, metal sign construction, etc.

COMPARABLE TO SOLID RIVETS Cherry Rivets have shear values comparable to solid rivets . . . They're much easier to use any time, anywhere. Only one man is needed . . . There's no "bucking" with Cherry Rivets.

VIBRATION-RESISTANT Cherry Rivets have excellent hole filling qualities and high clinching action between the shank of the rivet and the materials fastened. This gives Cherry riveted joints exceptional resistance to vibrational stresses.

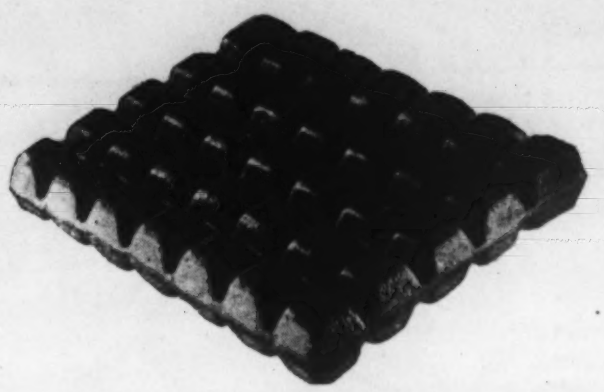
TAMPER-PROOF The tamper-proof qualities of Cherry Rivets add to their proved dependability. With the proper tools, however, a service representative can easily remove and replace Cherry Rivets without any change in the excellent appearance of the product.

Cherry Rivets are made from aluminum alloy, steel, or Monel. Standard rivets come in five diameters and two head styles. There is a wide range of grip lengths. Special heads, diameters, grip lengths, and alloys can be made to order. Write today for further information. Address Department K-251, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California.

CHERRY RIVETS. THEIR MANUFACTURE & APPLICATION ARE COVERED BY U.S. PATENTS ISSUED & PENDING

Cherry Rivet Company
LOS ANGELES 13, CALIFORNIA

CHERRY RIVETS ARE APPROVED BY CIVIL AERONAUTICS AUTHORITY AND UNDERWRITERS' LABORATORIES, INC.



A Little Does a Lot

GCC CERIUM METAL (Mischmetal) added in small quantities to many Ferrous and Non-Ferrous Metals improves the metallurgical and mechanical properties of the end products.

Discover how a little does a lot by writing for our informative bulletins.

GCC GENERAL CERIUM CO.
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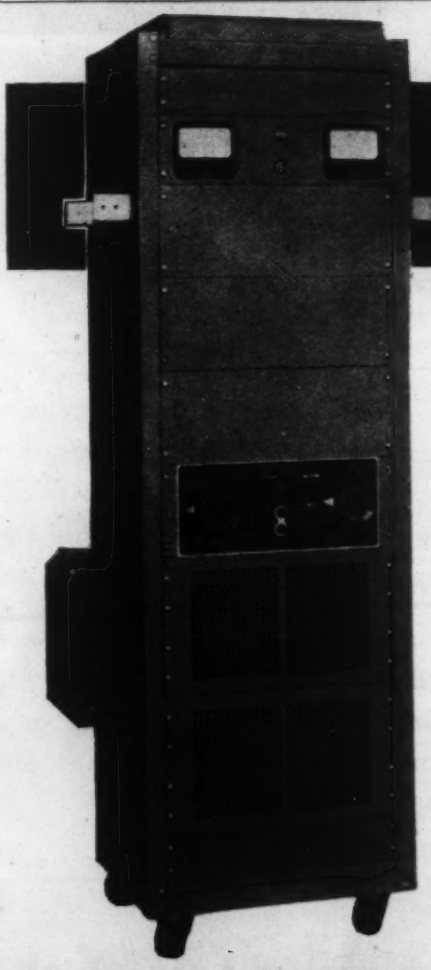

FOR ELECTROLYTIC CLEANING

The Green Electric line of Rectifiers, for supplying D.C. power, includes over two hundred standard types ranging from 6 volts to 60 volts and from 25 amperes to 5,000 amperes.

In addition, Green Electric have engineered several thousand custom-built units for particular applications or unusual plant layouts.

Green Electric, established since 1892, specialize *exclusively* in rectifier equipment.

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Please send me literature on Selectro-Platers and other rectifiers.

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CITY_____ ZONE_____ STATE_____

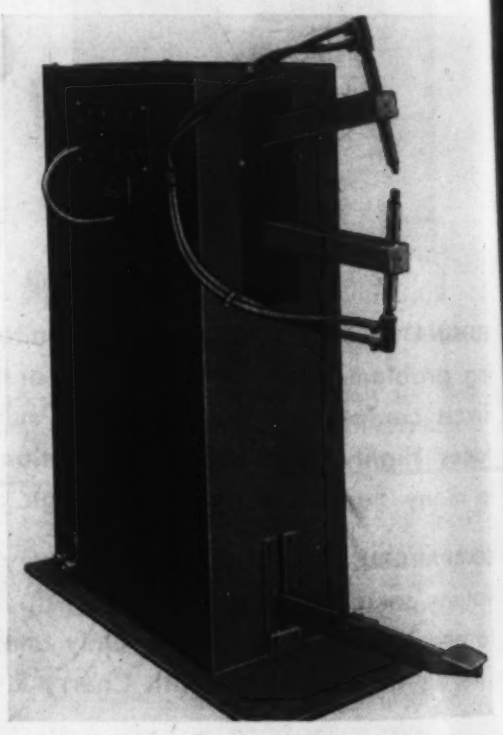
heat needed, and low current welding is established by high reactance windings which give added reactance and sustain proper open circuit voltage even at lower output settings.

The four-coil transformer controls flux diversion in such a way that output current is varied as required, without altering secondary voltage, reactance, or other characteristics which produce a smooth, stable arc. Output current is infinitely variable throughout the entire range, from the minimum practical welding amperage to the maximum capacity of the transformer.

Optional controls are available on the industrial models to meet special problems. Where frequent power shutoffs are desirable, as when considerable jig or fixture time is required, an on-and-off power control consisting of a primary contactor and a choice of three switches is recommended. For situations in which the welder can be stationed in an out-of-the-way spot, such as an overhead balcony, amperage remote control also is available.

Spot Welders Engineered for Production Welding

A new line of spot welders for production work are available from *Electric-Arc, Inc.*, 152-162 Jelliff Ave., Newark 8, N. J. The equipment is of the heavy-duty type unit featuring 8-step current control permitting 75% secondary voltage adjustment.



This spot welder features a spring loaded foot switch and welded steel casing.

The electrodes are standard size, water cooled. The equipment features a spring-loaded foot switch, ample ventilation, and arc welded steel casing with removable top and rear door for ease of inspection. The equipment operates on 220 v., 60 cycles, single phase a.c. If desired, these units can be furnished with magnetic contactors and weld timers.

Pictures Tell the Story of the Many Advantages of

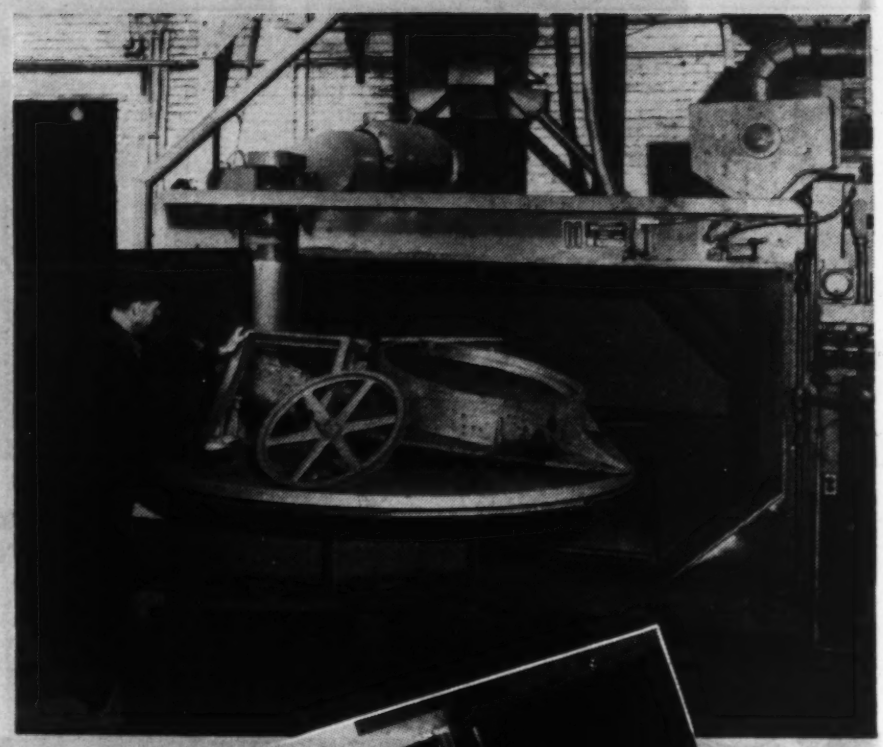
WHEELABRATOR SWING TABLES

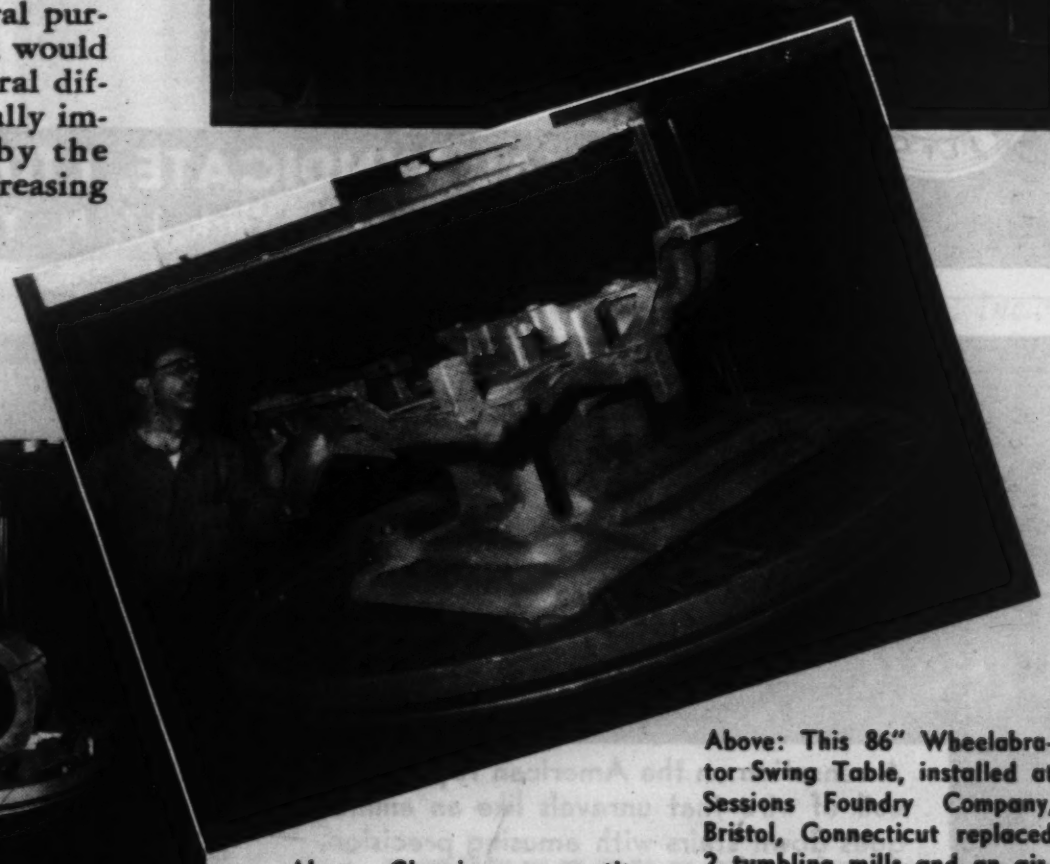
for Blast Cleaning

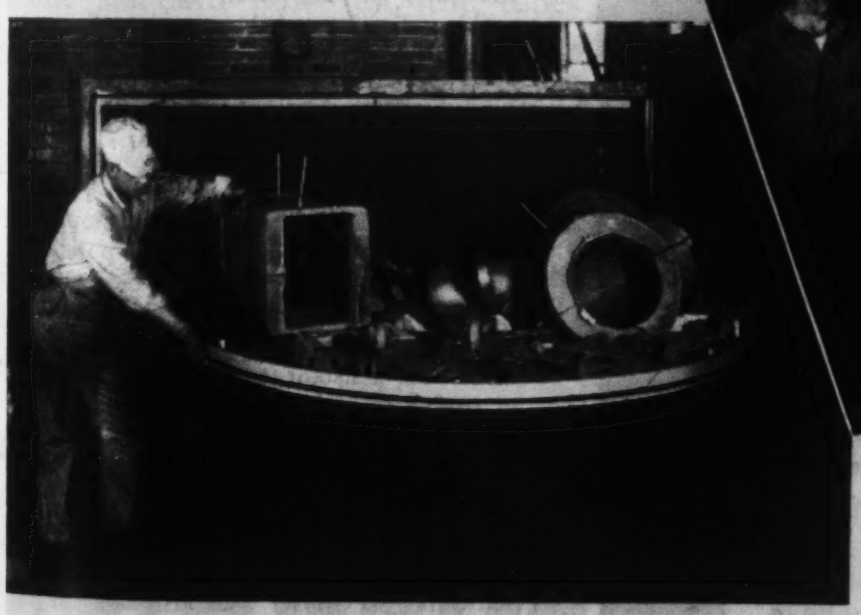
Examine the pictures and you will see how the Swing Table . . . an exclusive *American* development . . . solves some of the most troublesome and costly cleaning problems confronting management today.

Essentially, the machine is a blast room equipped with a rotating work table. As the door is opened, the table swings out with it for convenient loading or unloading. When the door is closed, the table rotates beneath the blast from an Airless Wheelabrator which scours away sand and scale from every nook and cranny.

Operating in this manner, the Swing Table replaces the unhygienic airblast room on 80% of all work and becomes a versatile general purpose machine for the shop whose work would otherwise require the purchase of several different types of cleaning machines. Equally important are the benefits provided by the Wheelabrator in slashing costs and increasing output.







Above: This 86" Wheelabrator Swing Table, installed at Sessions Foundry Company, Bristol, Connecticut replaced 2 tumbling mills and an airblast room. It cleans loads of castings weighing up to 5000 pounds in 4 minutes.

Above: Cleaning a quantity of castings in 3 hours that formerly required 8 hours to clean by airblasting, the 66" Swing Table installed at the Fairview Foundry Co., replaced an airblast room, a table and 3 tumbling mills.

Above: At the McNally-Pittsburgh Foundry Co., this Wheelabrator Swing Table cleans a 72" diameter sheave in 15 minutes that formerly required 4 hours to clean in an airblast room. Seven men were relieved for more productive work.

The new Swing Table Catalog No. 214-A is now available. It graphically describes the speed, economy and versatility of all five Swing Table sizes.

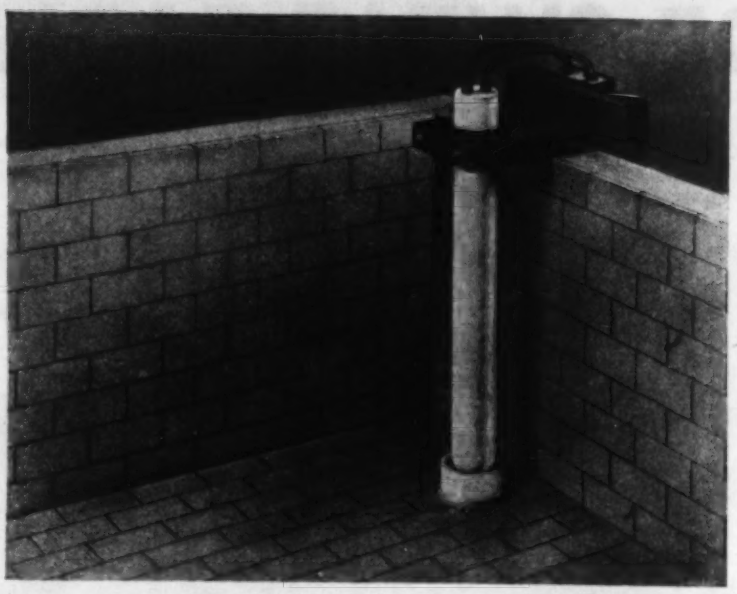
THE AMERICAN MOLDER
TRADE MARK REG. U. S. PAT. OFF.

American

WHEELABRATOR & EQUIPMENT CORP.
(FORMERLY AMERICAN FOUNDRY EQUIPMENT CO.)
538 S. Byrkit St. Mishawaka 7, Indiana

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST EQUIPMENT

IMMERSION HEATING WITH VITREOSIL (Vitreous Silica) HEATERS



When other methods are unsatisfactory, acid solutions in tanks of any material can safely be heated by Vitreosil electric immersion heaters.

Send for Bulletin #2

VITREOUS SILICA — VITREOSIL REG'D TRADE MARK

THE THERMAL SYNDICATE, LTD.
12 East 46th St. • New York 17, N. Y.

A sensation on the American toy market—"Slinky"... coil of wire that unravels like an animated accordion, goes down stairs with amusing precision.

JOHNSON is proud of the quality wire that goes into this coil spring, as well as other interesting commodities that require wire made exactly to specifications.

JOHNSON quality is constantly controlled by scientific chemical and physical analyses. Perhaps you have a product that needs the service of Johnson, and the Johnson laboratory—always at your service.

JOHNSON
STEEL AND WIRE COMPANY, INC.
WORCESTER 1, MASS.
New York Philadelphia Cleveland Detroit Akron Chicago
Atlanta Houston Tulsa Los Angeles Toronto

News of...

ENGINEERS COMPANIES SOCIETIES

Engineers

R. S. Reynolds, Jr. was recently elected president of the Reynolds Metals Co., having previously served as treasurer and vice-president. *Calvin Coghill,* formerly assistant treasurer, succeeds Mr. Reynolds as treasurer. *M. M. Caskie,* a vice-president and director of the company, has been elevated to executive vice-president. A new member of the firm is *Kenneth Mann,* a steel expert and formerly executive vice-president of Truscon Steel, who has been employed as a manufacturing vice-president, directing the production of all sheet, rod, extrusions and foil.

The Firth Sterling Steel & Carbide Corp. has appointed *Gilbert B. Richards* to the office of general sales manager, to coordinate the sales of the steel, carbide and tool making divisions of the company. Formerly, he held the positions of general sales manager of Bostitch, Inc. and commercial sales manager for Firestone Tire & Rubber Co.

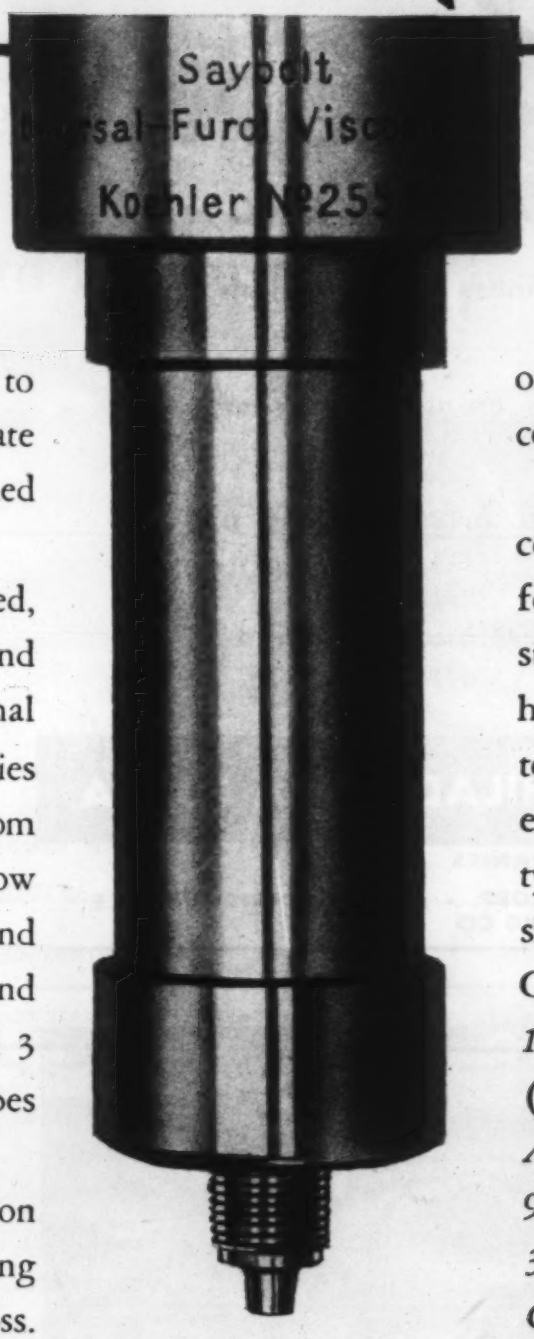
Maj.-Gen. *Joseph A. Teece* has been elected vice president of Fansteel Metallurgical Corp. He entered the employ of Fansteel in 1924 as assistant purchasing agent and rose to assistant to the president in 1939. Upon returning to Fansteel in 1946, after serving in World War II, his duties as assistant to the president were expanded to include production in addition to purchasing, personnel, labor relations, medical and safety.

The Yale & Towne Manufacturing Co. recently appointed *Otto G. Schwenk* as vice-president in charge of production. Mr. Schwenk previously was assistant to the president of the Weatherhead Co.

Harold G. Williams has joined H. Braun Tool & Instrument Co., Inc., as director of sales and engineering. Mr. Williams formerly served as chief metallurgist of the Instrument Specialties Co.

The election of *Donald Havens* as president of the Tech-Art Plastics Co. is one of several executive promotions in this company. Mr. Havens, formerly vice-president and treasurer, fills the vacancy left by the recent passing of *Valentine B. Havens.* Other elections and appointments include that of *Robert Clochessy,* now treasurer and general manager; *Harry W. Treckman,* as-

Ever measure a hole by stopwatch?



courtesy
Koehler Instrument Co.

THIS A.S.T.M. viscosity tube, used to test oil, has an opening so accurate to size its final dimension is determined by stopwatch.

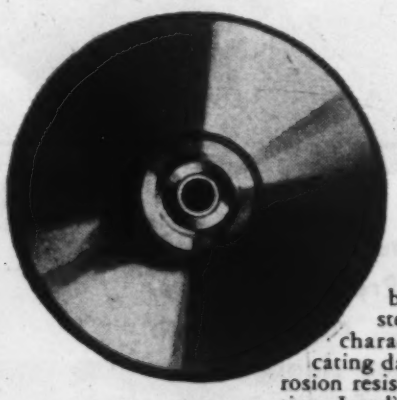
The nozzle is machined and drilled, then hardened; the hole itself is ground and honed to a tolerance of .0001". Final sizing, however, is made during a series of time trials—in which the oil flow from the tube on test is timed against the flow from a master tube. The hole is hand lapped after each trial — lapped and timed again and again — until, in a 3 minute standard flow test, the tubes match within 4/10 of a second.

Cost of making this super-precision instrument comes high—a "reject" during the finishing stages means serious loss. Hours of skilled labor might be wasted on material later found defective—while costs soar.

Frasse stainless steels have been successfully used in this rigid application for 8 years. If you like quality in your stainless, you'll find it in Frasse warehouse stock. As for variety, you're *invited* to be choosey. Frasse stocks stainless in every rolled form . . . in 7 different bar types alone — and in a wide range of sheets, strip, tubes, pipe and specialties. Call us. *Peter A. Frasse and Co., Inc., 17 Grand Street, New York 13, N. Y. (Walker 5-2200) • 3911 Wissahickon Avenue, Philadelphia 29, Pa. (Baldwin 9-9900) • 50 Exchange Street, Buffalo 3, N. Y. (Washington 2000) • Jersey City • Syracuse • Hartford • Rochester • Baltimore.*

FRASSE

for Stainless Steels and Tubing



NEW! FOR STAINLESS PIPE AND TUBE USERS!

This new 24 page Frasse manual is brimful of useful data on stainless steel tubular products. Includes type characteristics, physical properties, fabricating data, tolerances, standard finishes, corrosion resistance, and similar essential information. Invaluable for reference if you're working with stainless tube or pipe. Send the coupon for your free copy today.

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Please send me a complimentary copy of your new handbook on stainless steel, pipe and tubing.

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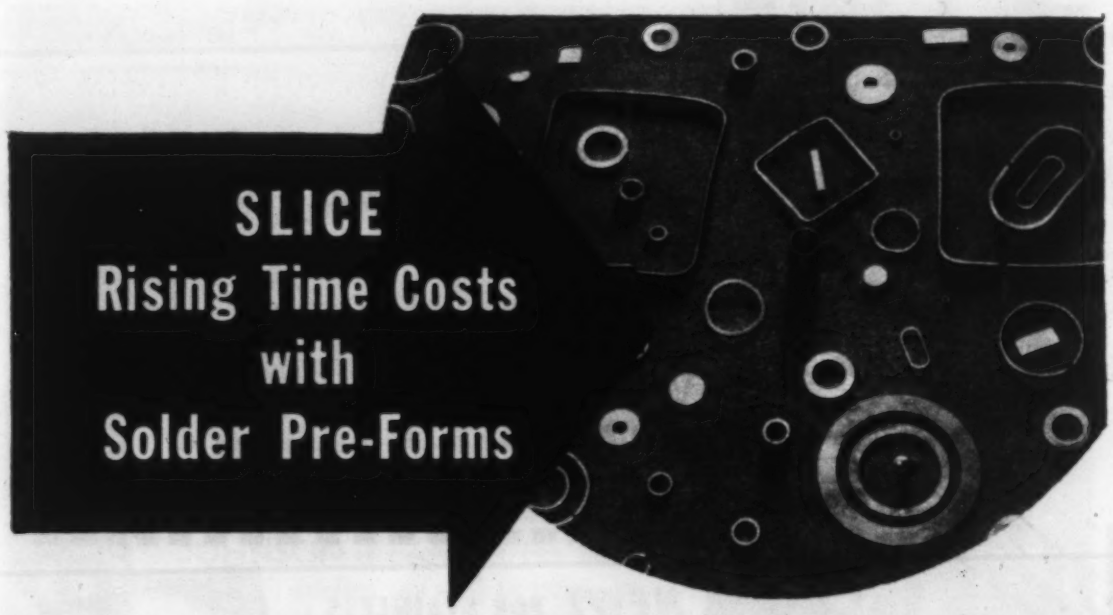
HIGH TENSILE MANGANESE BRONZE

- *high in strength, toughness and corrosion resistance . . . . . .*
- *long time favorite with manufacturers of marine fittings . . . . . .*
- *leaves sand clean and bright—takes a mirror-like finish . . . . . .*
- *recognized as the highest quality manganese bronze available . . . . . .*

AJAX METAL CO. PHILADELPHIA 23, PA.

ASSOCIATE COMPANIES

AJAX ELECTRIC • AJAX ELECTROTHERMIC CORP. • AJAX ELECTRIC FURNACE
AJAX ENGINEERING CO



SLICE Rising Time Costs with Solder Pre-Forms

Eliminate time-consuming manual solder operations in your assembly processes. Pre-formed rings, washers, discs, pellets, squares, etc., complete with flux, save time, trim labor costs, insure cleaner, more uniform, sturdier bonds. We meet your specifications in the widest variety of solder alloys. Consult with us on any solder or brazing problem.

(Literature on Request).

Soldering Specialties

Dept. E, Summit, N. J.

News of...

ENGINEERS
COMPANIES
SOCIETIES

sistant treasurer; *Herbert A. Tighe* continues as secretary; and *Edward V. Walsh*, assistant secretary and still general sales manager.

The resignation of Dr. *A. B. Parsons* as secretary of the American Institute of Mining & Metallurgical Engineers becomes effective in February 1949; but in the meantime he will be on leave of absence and located at 6091 Castle Dr., Oakland 11, Calif. *E. H. Robie*, who was Dr. Parson's principal assistant, will be acting secretary during the remainder of the year.

A series of important changes in the organization of General Motors Corp. resulted in the election of *Harlow H. Curtice* as executive vice-president, to be in charge of all general staff activities; *William F. Hufstader* was elected a vice-president, in charge of distribution staff, succeeding *W. G. Lewellen*, who resigned; and *Ivan L. Wiles*, another new vice-president, succeeds Mr. Curtice as general manager of the Buick Motor Div.

The Titan Metal Manufacturing Co. announces the election of *W. W. Sieg* as president of the company, succeeding *W. P. Sieg*, who was appointed vice chairman of the board of directors and chairman of the executive committee.

The appointment of *E. W. Chapman* as vice-president in charge of engineering was recently announced by the Tuthill Pump Co.

Ralph M. Bixler has been appointed sales manager of the Mill Products Div. of the Phosphor Bronze Corp.

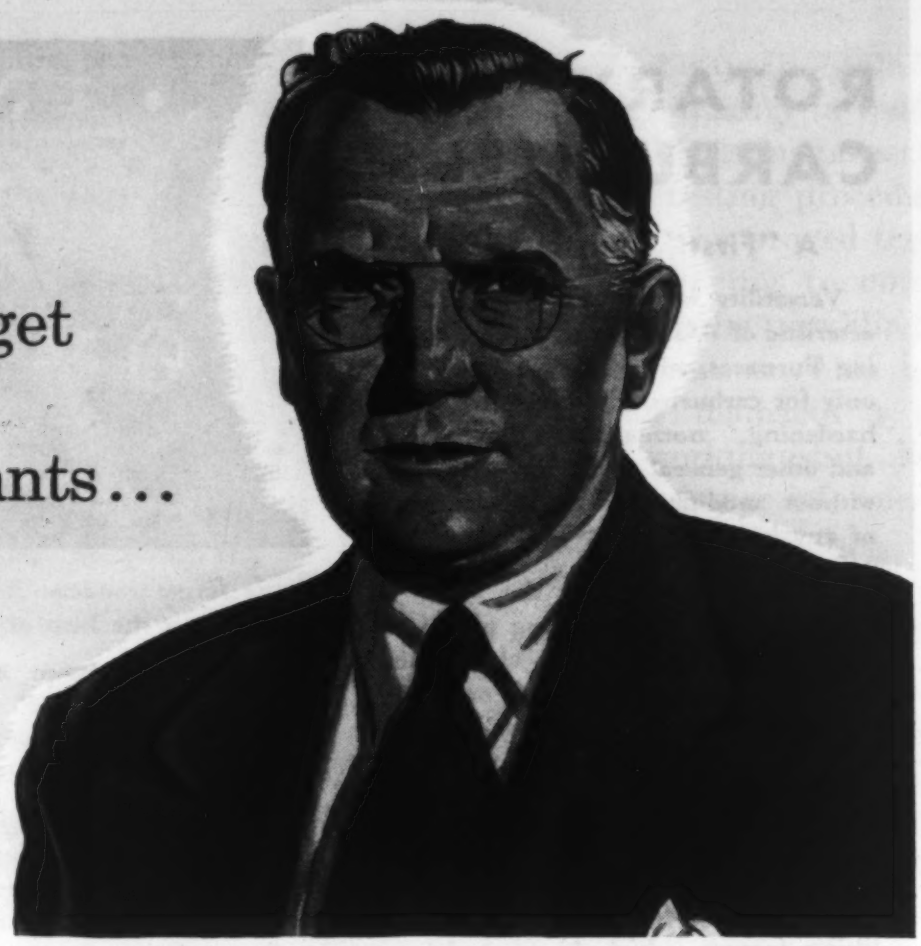
The Carborundum Co. has named *E. B. Force* as assistant vice-president, his former position as manager of the Refractories Div. now undertaken by *C. E. Hawke*. The new director of sales and sales administration is *E. R. Baxter*, succeeding Mr. Hawkes.

The election of *D. J. Erikson* as president of Hagan Corp. and its subsidiaries was announced recently. *J. M. Hopwood*, who held the position as president since 1918, is now chairman of the board of directors.

The promotion of *Leonard E. Parker* to vice-president and general manager of the Cummins Portable Tools Div. of Cummins Business Machines Corp. has just been made public. Prior to joining Cummins as consultant and technical adviser to the president, Mr. Parker served Stewart Warner Corp. and Skilsaw, Inc.

A new vice-president of General Electric Co. is *Raymond R. Rausch*, who will be in charge of company manufacturing policy. Mr. Rausch is taking over the position of *Elmer D. Spicer*, who has retired after 24 years of service. Another appointment is that of *Frank T. Lewis* as manager of manu-

If this customer could get all the Aluminum he wants...



HE: ***Every woman knows aluminum kitchenware! Millions will want my nursery equipment . . .***

WE: ***That's why saying NO is so tough . . .***

There is no mystery in the reasons. We have talked aluminum, aluminum, aluminum, for sixty years.

Manufacturers, and Americans in general, during the war, learned what aluminum could do. As it fought America's battles in the sky, they saw it win other battles against great stresses, against corrosion, against old-fashioned manufacturing methods. Hundreds of thousands of skilled American hands learned to work with aluminum . . .

All of these facts, put together, caused a kind of postwar revolution. A manufacturer of nursery equipment, or farm roofing, or appliances, or irrigation systems, redesigned his line to take advantage of aluminum's usefulness. *Suddenly, thousands of such manufacturers were clamoring for aluminum!*

So many that—with aluminum as with countless other products—the world demand exceeded the supply. And America's new aircraft program subtracts its large and necessary share.

That is why, right at this enthusiastic moment, events force us to learn to say NO. We must say a flat NO to those who want aluminum because they can't get their regular metal. A milder NO to new aluminum users with ideas that are economically sound. We will endeavor to supply them with the small amounts needed for experimental use. Very drastic NO's to many of our own fabricating plants, which, for some time, we have operated at only a fraction of their capacity.

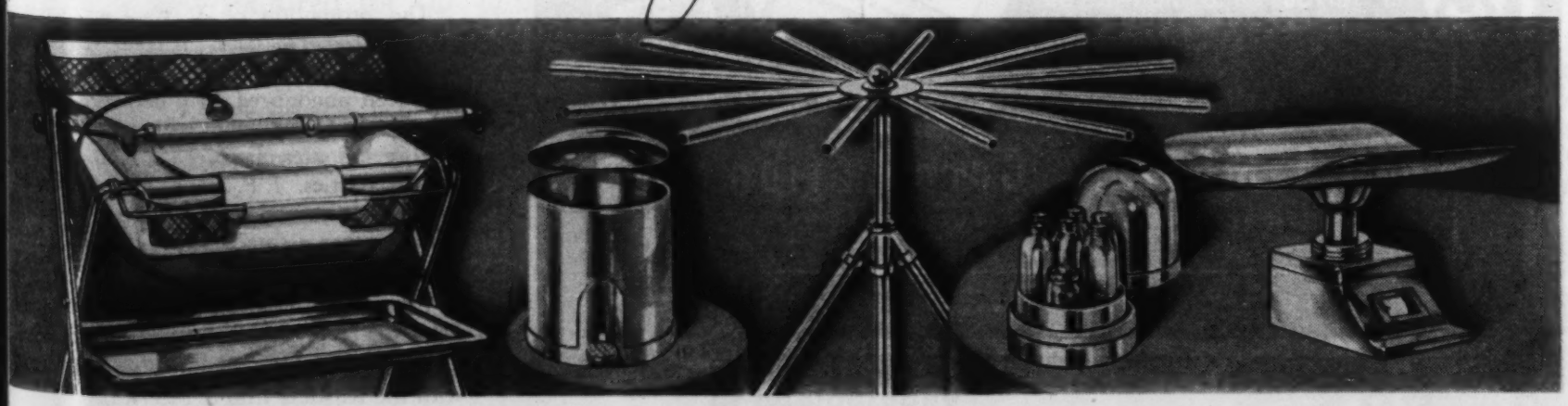
Every time we have to say NO to a customer, it will be the fairest NO we know. Our first obligation is, of course, to the host of old customers who have put all their eggs in the aluminum basket.

But there will be no light decisions. Your Alcoa salesman and his District Manager will work out the answers, as a team whose guiding motive is this:

We want more and more of your business, as soon as we can make more aluminum available.

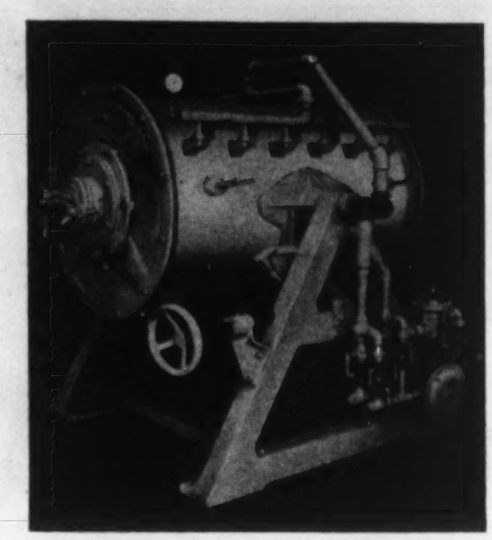
ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh 19, Pa. Sales offices in principal cities.

ALCOA *first in Aluminum*



ROTARY GAS CARBURIZERS

A "First" by A.G.F. Co.



Versatility is the outstanding characteristic of AGF Rotary Gas Carburizing Furnaces, which may be used not only for carburizing, but also for clean hardening, normalizing, annealing, and other general or atmospheric work without modification to the furnace of any kind.

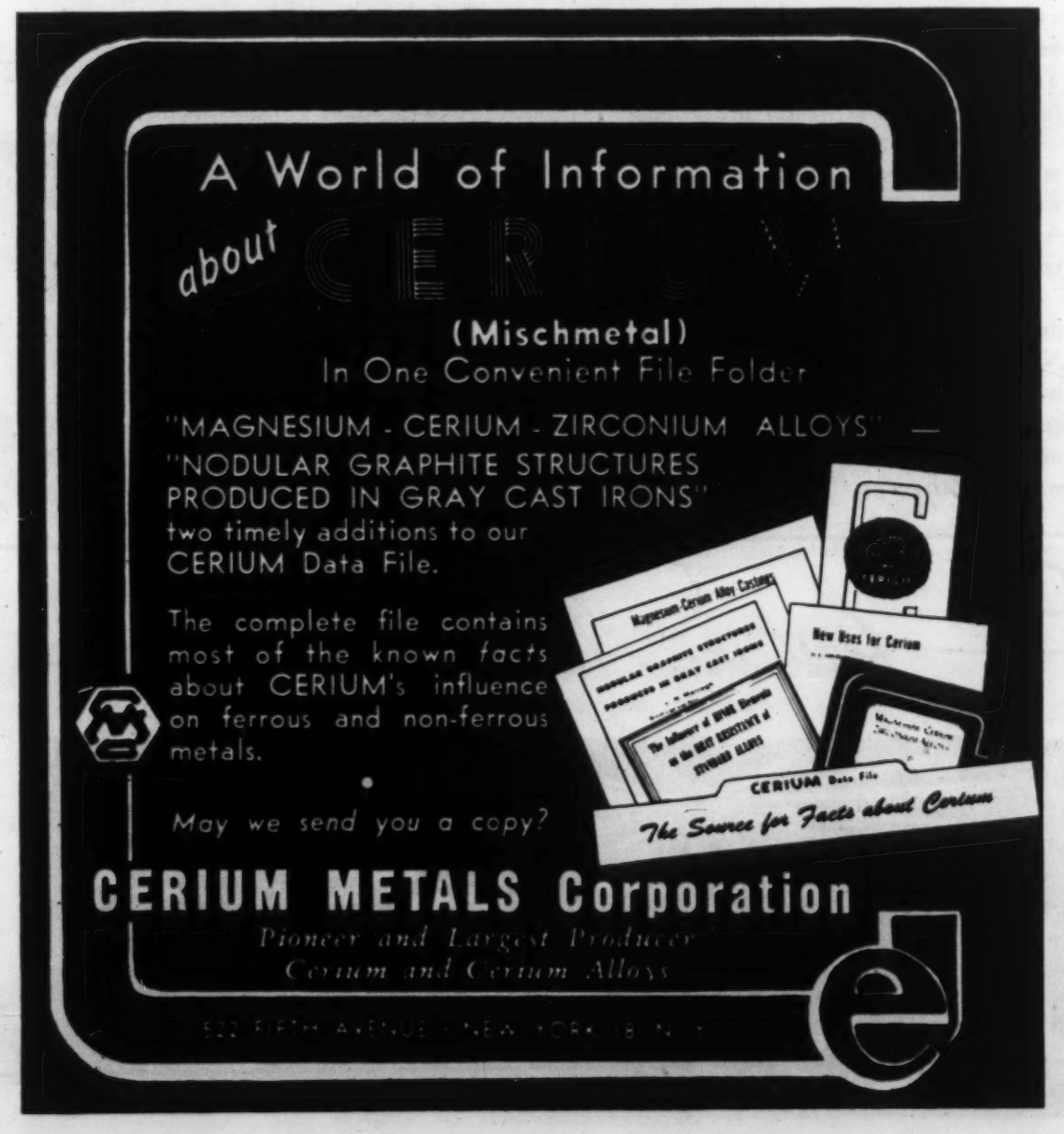
Uniform heating of the work is assured by the gentle mixing produced by the rotary action of the retort, which is heated by numerous carefully distributed and balanced gas burners. Carburizing or atmosphere gas is introduced through a simply-designed, trouble-free connection.

Charging and discharging of the work is accomplished by means of a tilting feature, which is power-driven on the larger models. The retort remains within the heat at all times.

The furnace shown above is the latest, improved AGF Rotary Gas Carburizer, batch type, with new maintenance-free roller bearing retort support.

AGF gas carburizing equipment also includes Continuous Rotary Furnaces and Vertical Retort Carburizers. Write for literature.

AMERICAN GAS FURNACE CO.
142 SPRING ST., ELIZABETH, N. J.


A World of Information
about CERIUM
(Mischmetal)
In One Convenient File Folder
"MAGNESIUM - CERIUM - ZIRCONIUM ALLOYS" —
"NODULAR GRAPHITE STRUCTURES PRODUCED IN GRAY CAST IRONS"
two timely additions to our CERIUM Data File.
The complete file contains most of the known facts about CERIUM's influence on ferrous and non-ferrous metals.
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CERIUM Data File
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CERIUM METALS Corporation
Pioneer and Largest Producer
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News of...

ENGINEERS COMPANIES SOCIETIES

facturing in G.E.'s Aeronautic and Ordnance Systems Divs., having previously been assistant manager of the Schenectady Works.

William F. B. Henderson has joined the E. W. Bliss Co. as executive vice-president, a position similar to that he held the last four years with the Clearing Machine Corp. A second appointment is that of *Paul S. Strecker,* assistant to the president, as works manager of the Toledo Machine & Tool Div. of Bliss. *R. E. Hinde,* formerly works manager, is continuing at the Toledo plant as assistant to the works manager handling special assignments.

The election of *Kenneth G. Donald* as president of Jack & Heintz Precision Industries, Inc. took place at a special meeting, following the resignation of *Byron C. Foy* as president and chairman of the board. Mr. Donald, who served as general manager of Jack & Heintz for several months, will continue as a vice-president of Robert Heller & Associates.

Brooks & Perkins, Inc. has appointed *K. C. Reeves* as an executive vice-president, Mr. Reeves having been a partner in Brooks & Perkins at the time of its formation, and treasurer since its incorporation.

A. Cristello has joined American Light Alloys, Inc. in the capacity of executive vice-president, his last position being the manager of Eclipse-Pioneer Foundries, Bendix Aviation Corp.

The promotion of *Arthur E. Kimball* to manager of development and sales for heavy grinding products in the Coated Abrasives Div. of the Minnesota Mining & Manufacturing Co. took place recently.

Harbison-Walker Refractories Co. has named *W. F. Godejohn* as assistant to the president.

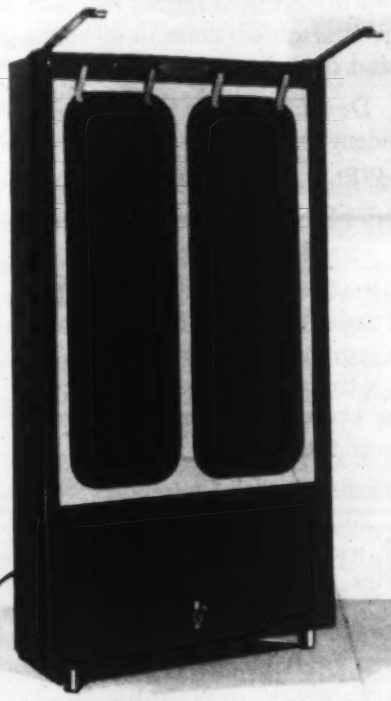
The appointment of *J. C. Kuhn* as general sales manager of Morse Twist Drill & Machine Co. has just taken place, following the resignation of *Mort Rainey* as vice-president and sales manager.

The promotion of *S. C. Lawson* from assistant general sales manager to general sales manager of Ampco Metal, Inc. has just been announced. Mr. Lawson succeeds *R. J. Thompson,* who will serve as engineering and sales manager for Ampco's West Coast activities. *J. P. Henry* has been named as assistant general sales manager, and *E. E. Whitson* has assumed the duties of advertising manager.

Samuel M. Gahagan is now associated with the Jessop Steel Co. as chief metallurgist, previously having been affiliated with the Rustless Iron & Steel Corp.

Regular inspection assures high welding quality levels . . .

One of the best ways to obtain consistently high quality in welding is to establish regular inspection with proved testing procedures. Radiography *is* a proved testing procedure, serving to control welding quality by providing objective information. This helps the operator maintain a high standard of workmanship...keeps plant and customer informed on the quality of every job.



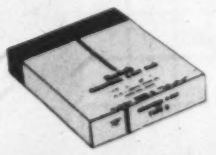
Test non-destructively with x-rays to assure weld quality

Radiographs of all types of welds provide visible information on internal gas and slag pockets, lack of penetration, and other internal weld weaknesses. They also indicate to experienced welding technicians the best method to be used in preventing such defects. Radiographs are the best assurance an engineer can have that a welding job is well done.

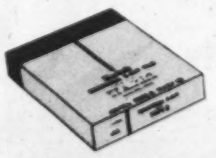
For maximum radiographic visibility . . . use Kodak Industrial X-ray Films

They provide the high radiographic sensitivity—the combination of speed, contrast, and fine grain—required for the detail visibility you need in critical examination of welds.

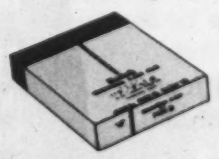
Eastman Kodak Company
X-ray Division • Rochester 4, N. Y.



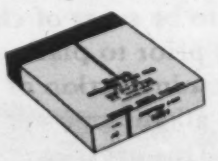
Kodak Industrial X-ray Film, Type A . . . for x-ray and gamma-ray work in sections where fine grain and high contrast are desirable for maximum sensitivity at moderate exposure times.



Kodak Industrial X-ray Film, Type K . . . designed for gamma-ray and x-ray radiography of heavy steel parts, and of lighter parts at limited voltages where high film speed is needed.



Kodak Industrial X-ray Film, Type M . . . first choice in critical inspection of light alloys, thin steel at moderate voltages, and heavy alloy parts with million-volt equipment.



Kodak Industrial X-ray Film, Type F . . . with calcium tungstate screens—primarily for radiography of heavy steel parts. For the fastest possible radiographic procedure.

"Kodak" is a trade-mark

RADIOGRAPHY . . . another important function of photography

Kodak

Handle Scrap *FASTER - EASIER*

This Burro is handling scrap faster and easier because it moved itself and several cars to the job quickly —and started work without delay. Burros equipped with magnet, clamshell bucket, dragline bucket, tongs or hook are saving time and money on many jobs in every type of industry. Their powerful draw bar pull (7500 lbs.) and fast travel speeds (up to 22 MPH) make them efficient switch engines too—you can spot cars where and when you want them at a moment's notice. There's no waiting time when a Burro is on *your* track.

Write for Descriptive Bulletins

CULLEN-FRIESTEDT, 1314 S. Kilbourn Ave., Chicago 23, Ill.

higher production starts with

PQ SOLUBLE SILICATES

PQ SILICATES FOR FABRICATING METAL CLEANERS

Metso Granular
($Na_2SiO_3.5H_2O$) Sodium Metasilicate. Free-flowing, white granular product.

Metso 99
($Na_3HSiO_4.5H_2O$) Sodium Sesquisilicate. White, granular, free-flowing.

GC
($Na_2O.2SiO_2$) Powdered Sodium Silicate. Hydrated, alkaline. Readily soluble.

SS-C-Pwd
($Na_2O.2SiO_2$) Anhydrous Silicate. Slowly soluble. Ground to pass 65 mesh.

Want to be surer of chemically clean metals prior to plating? Rely on the cleaning action of PQ Soluble Silicates, due to alkaline power as well as soluble silica. This exerts a special effect, usually available only in more expensive materials, i.e., it prevents removed dirt from re-depositing on clean metal.

For better results, for increased production, specify PQ Silicates in your cleaners. Ask for free copy of "Effect of Alkaline Detergents upon Metals."

PHILADELPHIA QUARTZ COMPANY
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Sodium Sesquisilicate U. S. Pat. 1948730, 2145749 • Sodium Metasilicate U. S. Pat. 1898707

News of...

ENGINEERS COMPANIES SOCIETIES

The current expansion of the engineering staff of the M. W. Kellogg Co. includes the addition of *Ronald B. Smith*, specialist in gas turbines, superchargers, condensers, etc.

Personnel changes in the West Mills Div. of Carnegie-Illinois Steel Corp. include the promotion of *J. Norman Quinlan* from division superintendent to assistant general superintendent; *Charles J. Hunter* becomes division superintendent, *Oscar Pearson* assuming Mr. Hunter's position as chief metallurgist and inspector; *Ragnar Overberg* succeeds Mr. Pearson as assistant in steel production and central mills.

R. R. Donaldson has become the new vice-president in charge of engineering of Hagan Corp.

Aldus C. Higgins, 75, for nearly half a century closely identified with the Norton Co., died Sept. 10. Mr. Higgins, at the time of his death, was chairman of Norton's executive committee, having previously served as president, general manager and chairman of the board of directors.

The Eastman Kodak Co. reports the death on Sept. 29 of Dr. *Samuel E. Sheppard*, associated with Eastman's Kodak Research Laboratories for 35 years. Specializing in research on the sensitivity of photographic materials, he was widely known for such nonphotographic discoveries as a way to use powdered coal as fuel for submarines and the electroplating of rubber coatings on nonorganic materials.

Companies

The *Walker Hydraulic Duplicator Co.* has been established at Standish, Mich., by C. E. Walker, who designed and built the first hydraulic duplicating attachments for machine tools.

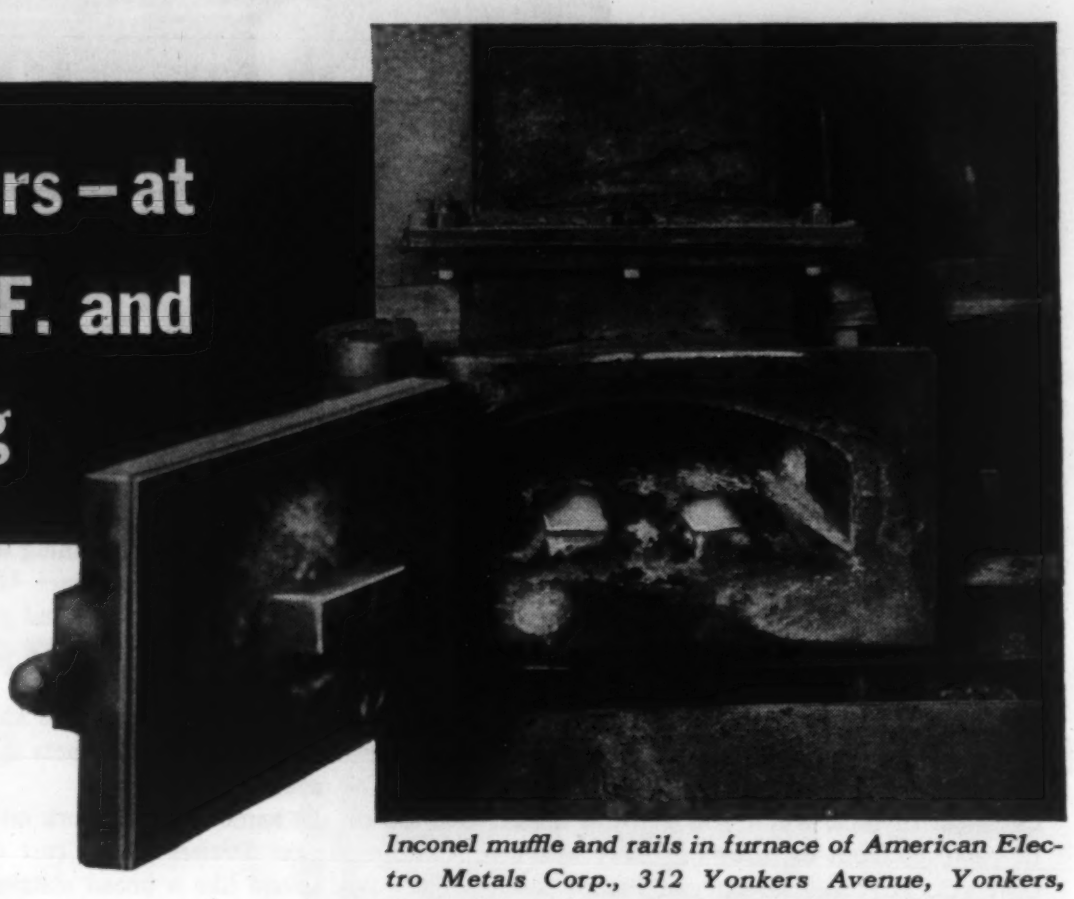
The acquirement by *Brooks & Perkins* of property adjoining their plant at 2457 W. Lafayette, Detroit, the new addition already in operation, will more than double their manufacturing property.

To house additional laboratories required for its ever-expanding research, *Battelle Memorial Institute*, Columbus, Ohio, will begin construction of a new half-million-

(Continued on page 164)

Over 10,500 Hours – at 1600° F. – 2200° F. and Still Going Strong

That's how 80-nickel, 14-chromium Inconel is serving as furnace rails, muffles, boats, and carrying trays for The American Electro Metals Corporation.



Inconel muffle and rails in furnace of American Electro Metals Corp., 312 Yonkers Avenue, Yonkers, N. Y. After 15 months, this Inconel equipment is in excellent condition with no evidence of weld failures.

To obtain the best possible service from furnace parts and equipment in their 24-hour-a-day, 7 days a week operation at temperatures between 1600° F. and 2200° F., American Electro Metals conducted experiments to decide which alloy they would use.

For two years they tested various high temperature alloys in actual service competition. Results convinced them that Inconel* D-type muffles, trays, and boats, all fabricated from sheet material, were far superior to others tested. In the hydrogen atmosphere they use in sintering pressed powdered metal parts, for example, they found that fabricated Inconel trays outlasted other alloys by 3 to 1.

So American's engineers standardized on Inconel furnace equipment. And now, after 15 months' continuous operation, here's what they have to say...

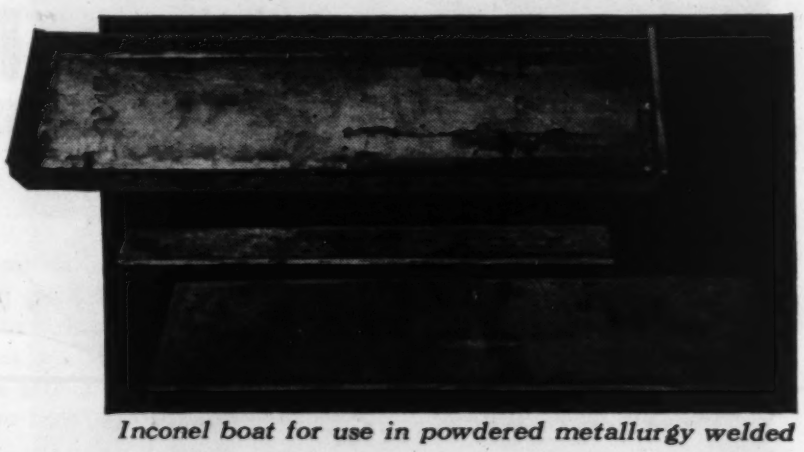
"We have used our D-type Inconel muffles in our furnaces for over 10,000 hours of operation now. And there is still no sign of failure."

And that's a typical Inconel service story. Strong, durable, Inconel does not scale away through oxidation. It resists embrittling effects of carburizing, nitriding, molten salts and other high temperature corrosive conditions.

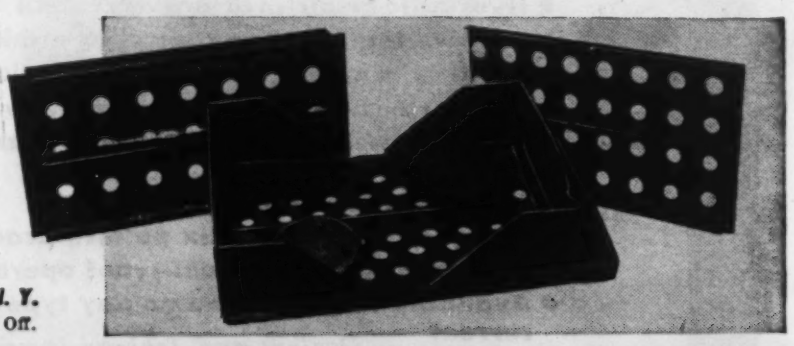
Today, the equipment you need can be made to order from Inconel. This alloy is immediately available in sheet, bar, rod, wire mesh, and seamless tubing.

The illustrated booklet "For Long Life in Heat Treating Equipment" tells you about Inconel – write for it today.

Inconel muffle, showing the weld construction used to extend muffle length.



Inconel boat for use in powdered metallurgy welded from Inconel sheet.



These perforated welded Inconel trays are designed to carry loads up to 75 lbs., at temperatures as high as 2100° F. Shown here still young and strong... after 10 months of service.

Also, get INCONEL Thermocouple Protection Tubes

They're seamless and corrosion resistant. Available in all needed sizes with one end closed and one end threaded. Ask your regular supplier.

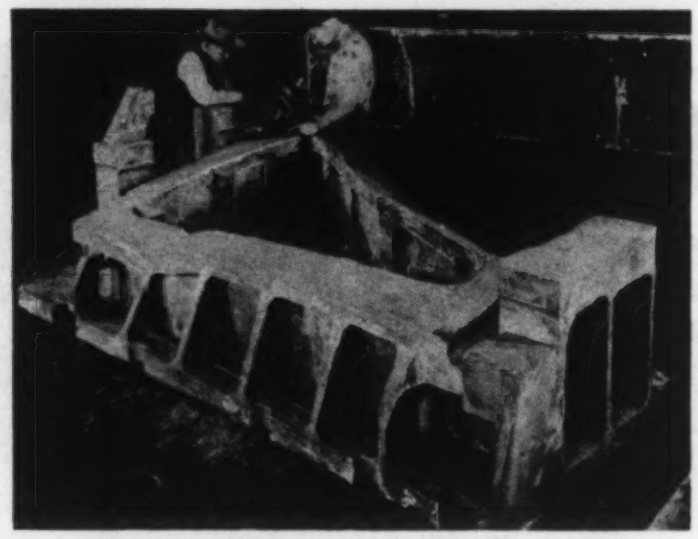
THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

*Reg. U. S. Pat. Off.

INCONEL* ... for long life at high temperatures

(80 NICKEL-14 CHROMIUM)

CHEAP CASTINGS CAN BE EXPENSIVE



Compared to the expense of machining this quarter panel, the cost of the casting is trivial. If a defect appeared after many hours of machine time had been spent on such a job, much more than the cost of the casting would be lost.

This doesn't mean you have to pay considerably more for sound, machinable castings. In fact, when you get that kind of castings from us, they probably won't cost you anything additional except the freight.

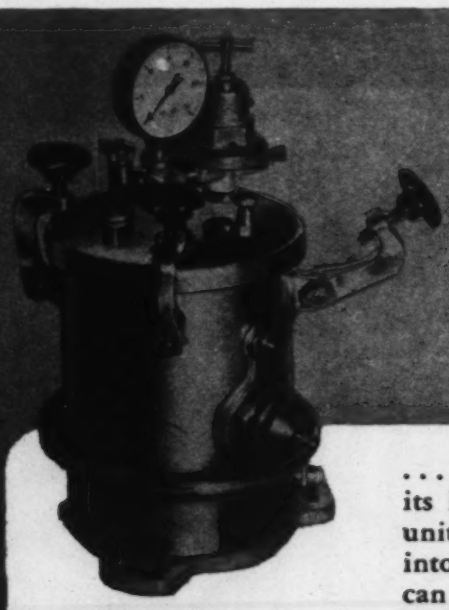
You'd be surprised to know how many customers at a distance are coming to us for gray iron, alloy, and *Strenes Metal* castings to save machining cost and grief. It's because they have learned by experience that it pays to get castings that don't show up blowholes, cold shuts, hard spots, cracks, and sponginess in the course of machining.

We do the same class of work on job castings as on *Strenes Metal* cast dies. That may sound like a broad statement, but we can prove it. If you want the proof, write or phone us.

THE ADVANCE FOUNDRY CO., DAYTON 3, OHIO

ADVANCE CASTINGS

STRENES METAL
ALLOY GRAY IRON
GRAY IRON



It's Here!

The **BARON** *formerly FINELT*

WAX INJECTOR

. . . acclaimed as the finest machine of its kind. A versatile, precision-made unit, ideally adapted to wax injection into both rubber *and* metal molds . . . can be used as either a hydraulic or air-pressure operated unit.

The BARON Injector

Check these features against any other wax injector on the market:

- **Hydraulic or air-pressure operation**
- **Positive temperature control to within two degrees**
- **Positive pressure control to a fraction of a pound**
- **Complete control over the quantity of wax injected**
- **Complete visibility of temperature and pressure at all times**
- **Full two-quart capacity**
- **Designed for rapid wax pattern production**
- **Designed for simple fool-proof operation**
- **Available for operation on any type of electric current**

Dealers and Jobbers Inquiries Invited

I.SHOR 64 W. 48th ST. • NEW YORK 19 • DEPT. M

News of...

ENGINEERS
COMPANIES
SOCIETIES

dollar laboratory adjacent to its Seventh Ave. Building, scheduled for completion in 1949.

The merger of the *Resinous Products & Chemical Co.* with the *Rohm & Haas Co.* was approved recently. Their sales operations will be continued as the *Resinous Products Div. of Rohm & Haas Co.*

More than 1500 persons witnessed the dedication of the world's largest X-ray development laboratory to Dr. William D. Coolidge, X-ray pioneer and director emeritus of the G.E. Research Laboratory. Located in Milwaukee, Wis., this building of the *General Electric X-Ray Corp.* increases their scope of operation nearly 100% within the last 12 years.

A new plant for the manufacture of grinding wheels was dedicated recently in Worcester, Mass., by the *Norton Co.*

The entire common stock equity in *Vascoloy-Ramet Corp.*, held by *Vanadium-Alloys Steel Co.*, was acquired by *Fansteel Metallurgical Corp.* Vascoloy-Ramet will continue to be operated under its own name as a division of Fansteel.

The *Tinius Olsen Testing Machine Co.* moved recently from Philadelphia to its new plant on Easton Rd., Willow Grove, Pa.

A combined production plant and research laboratory on a 35-acre site adjacent to Cleveland, Ohio, will be completed by next May, reports *Borg-Warner Corp.* This factory will house the company's Pesco Products Div., which will move from its present location at 11610 Euclid Ave., Cleveland.

Consolidation of the Shops and Piston Ring Divs. of *Koppers Co., Inc.*, into a new Metal Products Div., with Walter F. Perkins as general manager, is rapidly nearing completion.

Inland Steel Co. has licensed *M. W. Kellogg Co.* to produce stainless Ledloy steel, a patented process owned by Inland, which introduces small amounts of lead into molten steel.

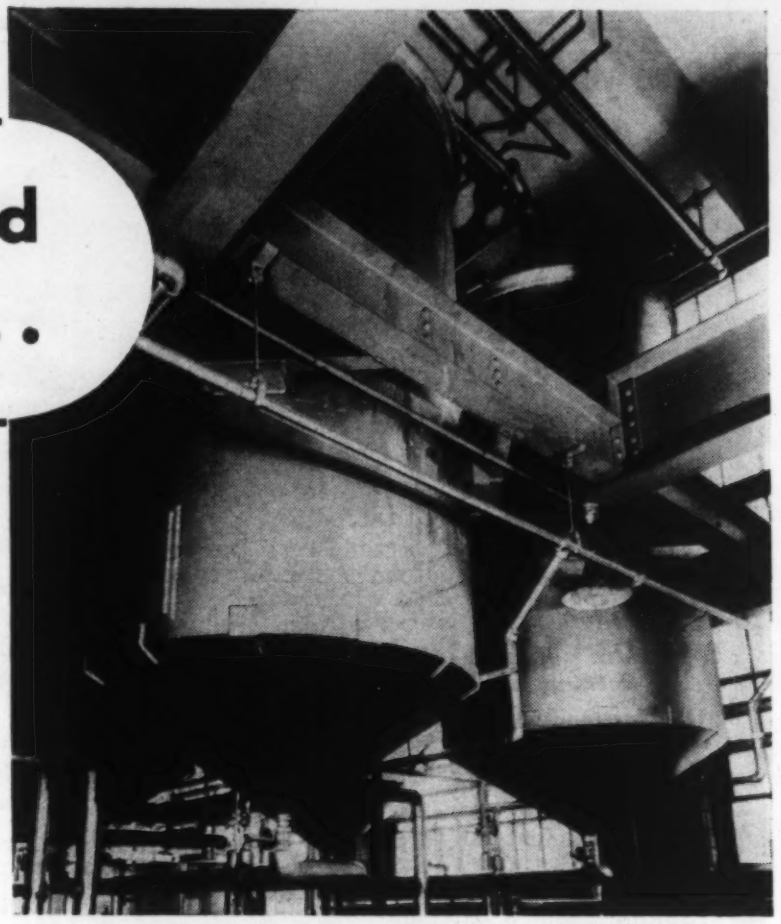
The Lockport, N. Y., plant of the *Monsanto Chemical Co.* will shortly be moved to the company's Plastics Div. at Springfield, Mass., to assure greater efficiency in its manufacturing operations.

A new custom heat treating plant of the *Lindberg Steel Treating Co.* has been constructed at 650 E. Taylor Ave., St. Louis, Mo. The facility will house 14 new heat treating furnaces as well as equipment for induction hardening and flame hardening operations.

New executive headquarters of the *Na-*

For new equipment and for repairing the old . . .

NICKEL-CLAD
STAINLESS-CLAD
INCONEL-CLAD
MONEL-CLAD
STEELS



Two glycerine bleach tanks built of Lukens 10% Nickel-Clad Steel.

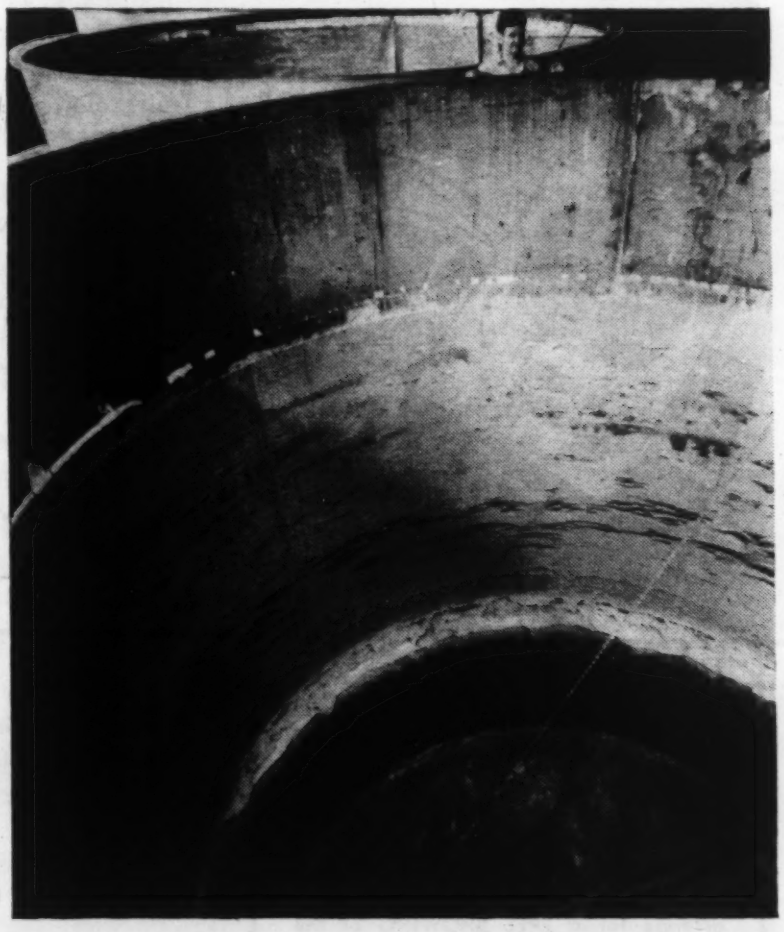
You've probably noticed the trend—new equipment given the corrosion-resisting ability of *solid* nickel, stainless steel, Inconel or Monel through the use of steel that is *clad* by Lukens with one of these metals. New equipment is, therefore, more economical to buy and operate.

Processors are similarly profiting as old equipment needs repairs. They use Lukens Clad Steels to replace old parts, obtaining protection of products against metallic and rust contamination, along with lower upkeep and longer equipment life.

There's a whole family of Lukens Clad Steels—Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad—enabling you to choose the metal best able to provide the protection you require. The extra smooth sodium hydride finish makes equipment extra easy to clean. Claddings 10% or 20% of total plate thickness suit most applications.

Bulletins 255 and 338 contain data on Lukens Clad Steels. For copies, write Lukens Steel Company, 446 Lukens Building, Coatesville, Penna.

Below: This nickel-clad soap kettle proved so successful that the top ten feet of a 50-year old steel kettle in the same plant were replaced with Lukens Nickel-Clad Steel.



LUKENS
Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

• • SPEED SCRAP TO THE MILLS TO MAKE MORE STEEL • •

Give your key men the up-to-the-minute facts on . . .
RESISTANCE WELDING

New fact program helps cut costs in your plant

Up-to-date knowledge of modern resistance welding is a *must* for your key men. Get this money saving information to them *now!*

IT'S EASY—General Electric has prepared all the facts in an easy-to-take, *visual* manner that's ideal for getting new ideas across *fast.*

Here's what the resistance welding program offers:

1. A fact-packed manual detailing the methods, practices, and equipment of *modern* resistance welding. It spells out objectively—*without sales bias*—the many ways in which this versatile industrial tool cuts costs and increases speed.

2. A full-color, sound motion picture, running about a half hour, showing how resistance welding solves problems similar to yours.

3. Fully-illustrated highlights booklets for individual study and review.

Convince yourself first—

We want you to judge for yourself whether the resistance welding program will pay off in your plant. That's why we offer business executives this chance to examine the *Resistance Welding Manual* without cost.

Showings cost you nothing. With your manual, we'll tell you how to arrange for a FREE film showing.

FREE
TO BUSINESS MANAGEMENT

Attach to your business letterhead

General Electric Co.
Section G684-3
Schenectady 5, N. Y.

Please send me a sample copy of the G-E *Resistance Welding Manual* without cost or obligation, with details on how I can arrange for a FREE SHOWING of the film. (Extra copies at regular manual price—$1.00.)

Name_____ Title_____

Company_____

Street_____

City_____

GENERAL ELECTRIC

News of...

ENGINEERS COMPANIES SOCIETIES

tional Cylinder Gas Co. have been established at 840 North Michigan Ave., Chicago. All administrative departments will be stationed there, but the Chicago district sales office remains at its present address.

Pettibone Mulliken Corp., Chicago, has acquired the *Universal Engineering Corp.* of Cedar Rapids, Iowa, this purchase now joining together the complete financial, production and sales facilities of these two companies with George Haiss Manufacturing Co., Inc., New York, and Beardsley & Piper Co., Chicago.

A new plant of the *Hunter Spring Co.* was formally opened at 1 Spring Ave., Lansdale, Pa. Designated as Plant No. 2, it will house the coiling, grinding, heat treating, finishing, plating, inspection and engineering departments, while the old Main St. Plant No. 3 has been wholly converted to warehousing service.

Pittsburgh Metal Processing Co., Inc. has removed its plant to Chapman & Lavic Sts., Sharpsburg, Pittsburgh 15.

"Precision Investment Casting" is the title of a new 16-mm sound motion picture in full color, running time about 12 min., which is available from the *Allis-Chalmers Manufacturing Co.*, Advertising & Industrial Press Dept., General Machinery Div., Milwaukee 1, Wis.

The *Die-Mold Corp.* has moved into its new plant recently completed at 6619 Motor Ave., Milwaukee 13, Wis.

Over 4200 patents of the *E. I. du Pont de Nemours & Co., Inc.* have been listed on the Patent Register of the U. S. Patent Office as available for licensing. The first official listing of these patents will appear in an early issue of the *Patent Office Gazette.*

A Sales Demonstration Room, which offers a variety of operating equipment for demonstrating many phases of metal cleaning, polishing and deburring at variable speeds, is now in operation at the headquarters plant of the *Osborn Manufacturing Co.*, Cleveland.

Societies

The *Gray Iron Founders' Society* has moved into its new suite of offices in the National City Bank Building, Sixth & Euclid Aves., Cleveland 14.

Anaconda PHOSPHOR BRONZE

Complete range of alloys

IN SHEETS
PLATES, STRIPS,
WIRE, RODS, BARS,
SEAMLESS TUBES &
SPECIAL SHAPES

The American Brass Company offers Anaconda Phosphor Bronze in 10 standard compositions (including a free-cutting alloy) with tin content ranging from 1.25 percent to 10.5 percent.

Tell us what you make and how it's used. Our Technical Department is at your service in helping you select the correct alloy, the most serviceable temper, the most economical form.

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
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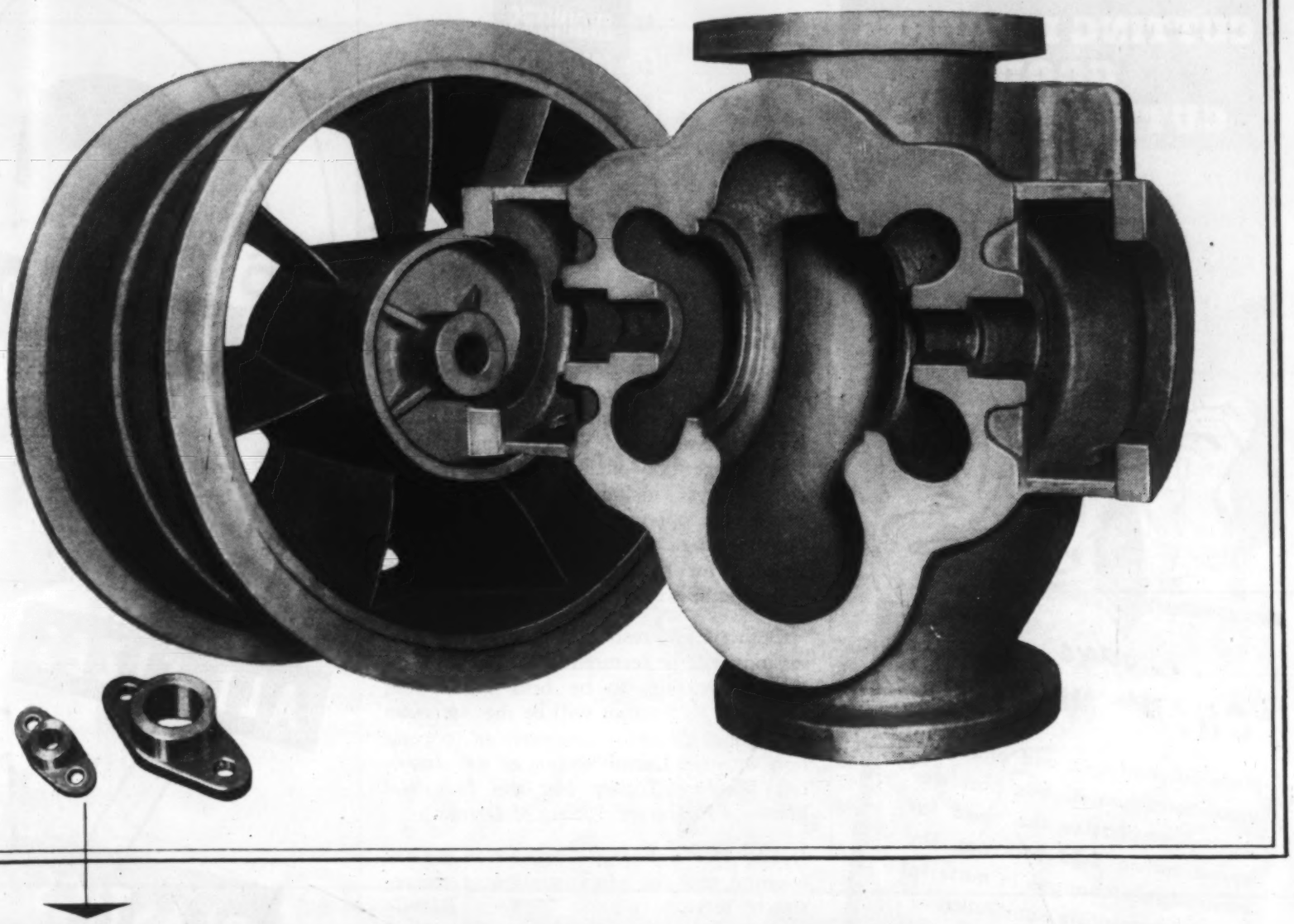
HIGH TENSILE STRENGTH
ELASTIC LIMIT
RESISTANCE TO FATIGUE
RESISTANCE TO CORROSION
RESISTANCE TO WEAR



"Custom-Engineered" Castings — for Long Range Economy

For longer, more economical service, N-B-M non-ferrous structural castings are tailor-made to your own specific application

Seldom are two structural casting problems precisely the same. A pump housing, for instance, presents certain requirements, while an impeller may call for a completely different alloy and casting technique.

Because of these innumerable combinations, N-B-M engineers make a specialty of research and manufacturing development — an approach that in the last 74 years has built up a tremendous backlog of experience in solving the most complex problems of casting design.

The unique engineering service of National Bearing Division includes a complete study of the important factors involved in each casting application. The unvarying result of this N-B-M service is to find the answers to such problems as:

The Proper Alloy—for long, trouble-free service and increased resistance to corrosion.

The Proper Casting Design—for a high factor of strength to handle safely the projected loads, pressures and stresses.

The Proper Casting Technique—for close tolerances consistent with maximum economy and ease of finished machining operations.

Any successful application of a structural part—large or small — depends on the correct solution to these basic problems of design. Let the specialized approach and broad experience of National Bearing Division find the right answers for you.

NBM

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

ST. LOUIS • NEW YORK

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

TODAY'S METAL CUTTING REQUIRES GOOD CUTTING FLUID

. . . says

"CHIP" WRIGHT

Material shortages and other unusual conditions of this post war period emphasize the need for sound cutting fluid practices. Uncontrollable changes in material quality necessitate substitution . . . calling for cutting fluids with wide latitudes and broad tolerances. When you are faced with such machining problems, the smart thing is to use the "know-how" of established cutting oil people. They have the broad, practical experience based on many years of solving difficult machining problems, and the technical knowledge and facilities to apply it to your job.

—Chip

An Economical Solution

SUPERKOOL

Base Cutting Oil

SuperKool Base Cutting Oil is available already correctly mixed for your convenience. Eliminating on-the-job mixing makes possible worthwhile economies in time, labor and money. For recommendations of SuperKool mixes, consult a Stuart service engineer.

Another Time-Tested Stuart Product

D. A. Stuart Oil CO.

2745 SOUTH TROY STREET, CHICAGO 23, ILL.

News of...

ENGINEERS COMPANIES SOCIETIES

The *James F. Lincoln Arc Welding Foundation* has announced that from now until Apr. 1, 1949 is the period for submitting entries in its annual Engineering Undergraduate Award and Scholarship Program. This competition offers to engineering undergraduates (including agricultural engineers) the opportunity to compete in the preparation of papers on various phases of welding for monetary awards as well as scholastic and industry recognition.

Both arc and resistance welding technical sessions will be featured at a conference on electric welding, to be held in Detroit, Dec. 6 to 8. Sponsor will be the *American Institute of Electrical Engineers* in cooperation with the Detroit section of the *American Welding Society* and the *Industrial Electrical Engineers' Society of Detroit.*

The *Atomic Energy Commission* has announced that the administration of the research service contract between *Battelle Memorial Institute,* Columbus, Ohio, and the Commission was assumed by the *Office of Chicago Directed Operations.* The contract, which involves research and services in the field of metallurgy, had previously been administered by the Oak Ridge Directed Operations office of the Commission.

The activities and Central Office of the *American Society of Tool Engineers* has been moved to its new headquarters on Puritan Ave., between Monte Vista and Manor Aves., Detroit.

A new hydraulic testing machine capable of stressing structural materials to a maximum tension or compression load of 200,000 lb. is to be installed at the *New York University College of Engineering.*

The newly elected officers of the *Acid Open Hearth Research Assn.* are G. S. Baldwin, president; C. N. Arnold, vice-president; F. C. T. Daniels, secretary; and A. R. Altman, treasurer. The Executive Committees consist of F. H. Allison, R. W. Devine, H. E. Dowie, F. B. Foley, C. R. Funk, W. E. Harvey, R. J. Meyers, and, as director of research, Dr. G. R. Fitterer.

Winners of the 1947-48 resistance welding contest sponsored by the *American Welding Society* were as follows: Industrial Div.—first prize to F. G. Harkins, Solar Aircraft Co.; second prize, R. C. Jones, Taylor Winfield Corp.; and third prize to C. E. Smith and R. H. Blair, of the same company. In the University Source Div., first prize went to W. F. Hess, W. D. Doty and W. J. Childs, all of Rensselaer Polytechnic Inst.; and second prize to W. F. Hess and W. J. Childs, Rensselaer.

To be specific, American Hard Rubber Company offers you compression and injection molding, extruding, stamping, machining, and other fabrication of Ace Hard Rubber, Okon, Ace-Saran, cellulose acetate, ethyl cellulose, polyethylene, and other plastics. A gold mine of helpful information is available free. Just write on your company letterhead for the new HARD RUBBER & PLASTICS HANDBOOK.

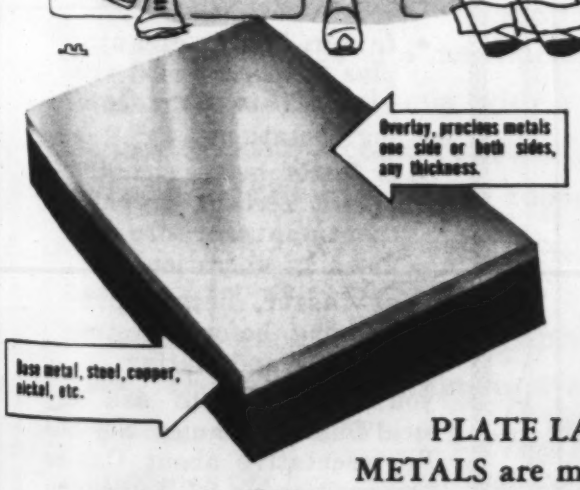
ACE HARD RUBBER & PLASTICS

AMERICAN HARD RUBBER COMPANY

11 MERCER ST., N. Y. C. 13

There are Two Sides to Our Story...

AND TO GENERAL PLATE LAMINATED METALS



Both Mean Performance and Economy To You

GENERAL PLATE LAMINATED METALS are made by permanently bonding, under tons of pressure, a *thin* layer of silver to a *thicker* inexpensive base metal. This gives you metals that are not only less expensive than solid silver but are stronger, harder and more serviceable for better performance.

The silver, or other precious metal, provides better electrical conductivity or corrosion resistance . . . the base metal cuts your costs way down. In addition, this combination is easier to solder, braze or spot weld...can be fabricated into parts more easily . . . gives long-lived service.

General Plate Laminated metals are available in sheet, wire and tube with the silver on one side, both sides. Inlaid stripe, elevated stripe and edgelay materials for economical contacts are also available. Write for complete information on the General Plate story.

GENERAL PLATE DIVISION

of Metals and Controls Corporation

611 FOREST STREET, ATTLEBORO, MASSACHUSETTS

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30 Church St., New York, N. Y. • 205 W. Wacker Drive, Chicago, Ill. • 757 W. Third St., Mansfield, Ohio • 36 Eastern Ave., Pasadena, Calif.

Get these new facts on Arc Welding to decision-makers in your plant

This easy-to-take 'Pack of Facts' makes the information crystal-clear

Today's arc welding offers the key men in your plant unprecedented opportunities to cut costs . . . improve quality . . . lick difficult production problems. Get them the latest facts on this versatile industrial tool *now!*

IT'S EASY—General Electric, as a service to industry, has prepared the facts for you in visual terms that are easy-to-take . . . linger in the memory.

Here's what the arc welding program offers:

1. A fact-packed manual, describing practical applications of electric arc processes . . . production feats. *Without sales bias,* it surveys the field *authoritatively.*

2. A full-color, sound motion picture, running thirty minutes, which shows arc welding increasing production and cutting costs in plants like yours.

3. Fully-illustrated highlights booklets, for individual study and review.

Convince yourself first—

We want *you* to be the judge of what these arc welding facts can do. That's why we offer business executives this chance to examine the *Arc Welding Manual* without cost.

Showings Cost You Nothing—With your manual, we'll tell you how to arrange for a FREE SHOWING of the film.

FREE
TO BUSINESS MANAGEMENT

Attach to your business letterhead

General Electric Co.
Section K684-2
Schenectady 5, N. Y.

Please mail me a sample copy of the G-E *Arc Welding Manual* without cost or obligation, with details on how I can arrange for a FREE SHOWING of the film. (Extra copies at regular manual price—$1.25.)

Name_____ Title_____
Company_____
Street_____
City_____

GENERAL ELECTRIC

News of...

ENGINEERS COMPANIES SOCIETIES

Meetings and Expositions

MEEHANITE CASTING MANUFACTURERS, annual meeting. Pittsburgh, Pa. Nov. 11-13, 1948.

NATIONAL TOOL & DIE MANUFACTURERS ASSN., annual meeting. Milwaukee, Wis. Nov. 14-17, 1948.

STEEL FOUNDERS' SOCIETY OF AMERICA, fall meeting. Hot Springs, Va. Nov. 15-16, 1948.

NATIONAL FOUNDERS ASSN., annual meeting. French Lick, Ind. Nov. 18-19, 1948.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. New York, N. Y., Nov. 28-Dec. 4, 1948.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York, N. Y. Nov. 29-Dec. 4, 1948.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Electric Furnace Steel Committee, annual meeting. Pittsburgh, Pa. Dec. 2-4, 1948.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, annual meeting. New York, N. Y. Dec. 2-4, 1948.

INSTITUTE OF THE AERONAUTICAL SCIENCES, Wright Brothers lecture. Washington, D. C. Dec. 17, 1948.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Materials Handling and Management Divs. meeting. Philadelphia, Pa. Jan. 10-14, 1949.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. Jan. 10-14, 1949.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland, Ohio. Jan. 14, 1949.

INDUSTRIAL FURNACE MANUFACTURERS ASSN. Cleveland, Ohio. Jan. 24-25, 1949.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. Jan. 24-27, 1949.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago, Ill. Feb. 9-10, 1949.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. San Francisco, Calif. Feb. 14-17, 1949.

This

. . . may be just the cleaner you need

OAKITE Composition No. 97 is a new emulsifiable solvent cleaner that dilutes with water for use in spray washing machines.

Oakite Composition No. 97 has proved its ability to remove buffing compounds . . . drawing and stamping compounds . . . cutting and grinding lubricants . . . mill and slushing oils and other rust-preventives . . . metal chips . . . and many other types of dirt.

Oakite Composition No. 97 is successfully washing steel, cast iron, brass, aluminum and zinc parts of all sizes and descriptions.

If you need . . .

- faster, better cleaning *plus temporary rust prevention* between machining operations . . .
- or faster, better cleaning before certain prepaint treatments or organic finishing operations . . .
- or faster, better precleaning before electrocleaning and plating . . .

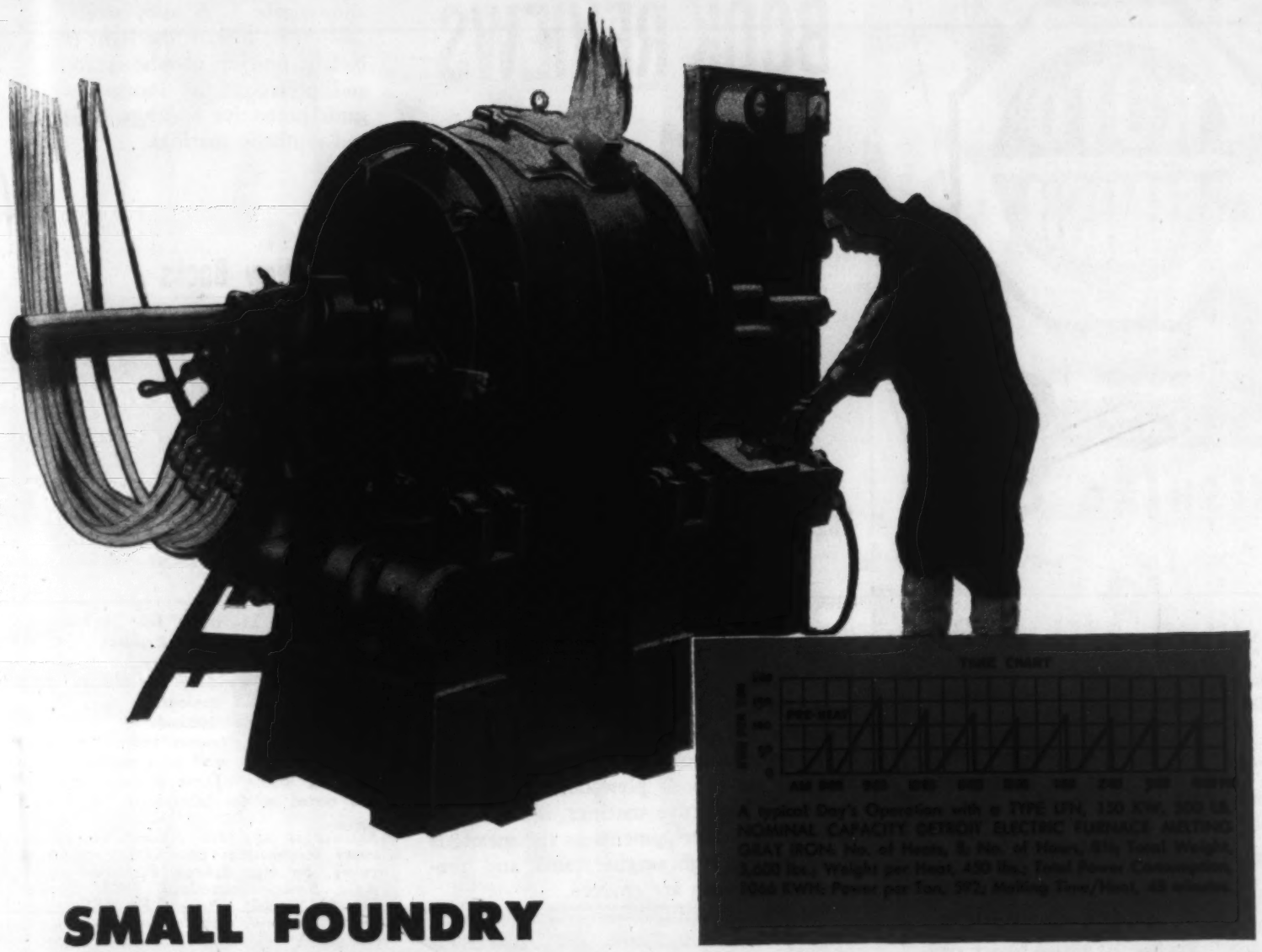
you will want to ask the local Oakite Technical Service Representative about Oakite Composition No. 97. Telephone him or write us today.

OAKITE PRODUCTS, INC.
30H Thames Street, NEW YORK 6, N. Y.

Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE

Specialized Industrial Cleaning
MATERIALS • METHODS • SERVICE



TIME CHART

A typical Day's Operation with a TYPE LFN, 150 KW., 500 LB. NOMINAL CAPACITY DETROIT ELECTRIC FURNACE MELTING GRAY IRON: No. of Heats, 8; No. of Hours, 8½; Total Weight, 3,600 lbs.; Weight per Heat, 450 lbs; Total Power Consumption, 1066 KWH; Power per Ton, 592; Melting Time/Heat, 48 minutes.

SMALL FOUNDRY casts 12,000 threading dies weekly with DETROIT ELECTRIC FURNACE

A BOTTLENECK that curtailed production of small castings, poured at high temperatures, *was quickly broken* at a manufacturing plant in northwestern Pennsylvania with a fast melting Detroit Rocking Electric Furnace. The company established their own 7-man foundry, installed a Type LFN, 150 Kw., 500 lb. capacity Detroit Electric Furnace — and now they're melting 450 lb. heats of gray iron to pour 12,000 castings per week. Daily power consumption averages 1050 Kw hours or 590 KWH per ton. Melting time is 48 minutes per heat. Metal is of *higher and more uniform quality*, because the one-man controls on the Detroit Electric Furnace consistently *maintain high pouring temperatures desired*—2900°F. —and afford constant regulation of melting time, composition, and other melting factors.

The furnace shell of a Detroit Electric Furnace *is easily removed*, and in the event of a burned out lining, a spare, previously lined, shell can be installed with *only a brief interruption of production.* Detroit Electric Furnaces are made in various sizes and capacities. Send us your production requirements and our engineers will recommend the specific model designed to speed melting of ferrous and/or non-ferrous metals in your plant.

DETROIT ELECTRIC FURNACES

ETROIT ELECTRIC FURNACE DIVISION • KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN
OREIGN OFFICES: BIRLEC, LTD., Birmingham, England, Representative for Europe and British Commonwealth excluding Canada. EQUIPAMENTOS DUSTRIAS "EISA" LTD., Sao Paulo, Brazil, Representative in Brazil. M. CASTELLVI, INC., 150 Broadway, New York 7, N. Y., Representative in ile, Argentina, Peru, and Venezuela. CASA COVACEVICH, Mexico City, D. F., Mexico.

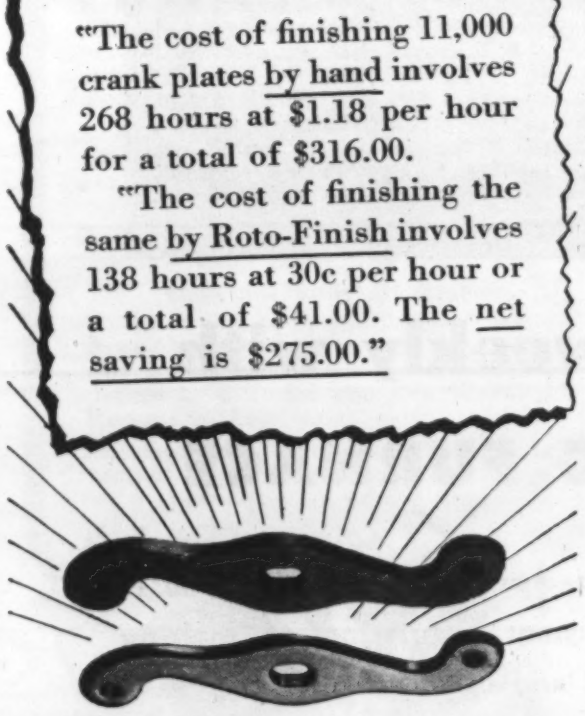
ROTO FINISH
Trademark Reg. U. S. Pat. Office

DOES CUT FINISHING COSTS

FISHING REEL MFR. REPORTS . . . (NAME ON FILE)

"The cost of finishing 11,000 crank plates by hand involves 268 hours at $1.18 per hour for a total of $316.00.

"The cost of finishing the same by Roto-Finish involves 138 hours at 30c per hour or a total of $41.00. The net saving is $275.00."



Unretouched illustration shows crank plate for fishing reel; above, before Roto-Finish deburring and finishing; below, after Roto-Finishing.

Such savings are possible in your finishing department, too! See how Roto-Finish produces a semi-lustrous surface uniformly on one or a thousand pieces; how it handles precision work. Send sample die castings, stampings, machined parts, forgings for processing. Include finished part for guide. No obligation! THE STURGIS PRODUCTS CO., 860 Jacob Street, Sturgis, Michigan.

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Frederic B. Stevens of Canada Limited
Windsor, Canada
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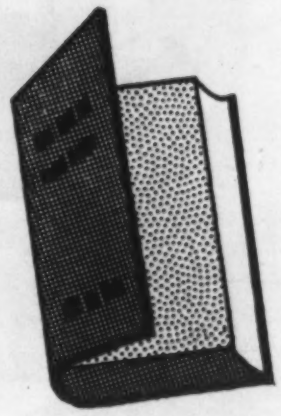
ROTO-FINISH
THE ENGINEERED
MECHANICAL FINISHING PROCESS

BOOK REVIEWS



Engineering Materials

ENGINEERING MATERIALS — SECOND EDITION. *By Alfred H. White. Published by McGraw-Hill Book Co., Inc., New York, 1948. Cloth, 6¼ x 9¼ in., 686 pages. Price $6.00.* The second edition of this very good book has been brought up-to-date. Chapters on alloy steels and light metals have been almost completely rewritten. Material on wood, plywood, other laminates, and protective coatings, is almost all new. Recent developments in the materials of airplanes, lightweight trains and prefabricated houses are covered.

Among the subjects are: Fundamental properties of solids; iron and iron-carbon alloys; manufacture of iron and steel; low alloy steels; high alloy steels; shaping and fabricating metals; the light metals; the soft metals; bearing metals; corrosion of metals and protection by inorganic coatings; organic protective coatings; plastics, laminates and synthetic coatings.

Other New Books

PITTSBURGH INTERNATIONAL CONFERENCE ON SURFACE REACTIONS. *Published by Corrosion Publishing Co., Pittsburgh 12, 1948. Paper, 8½ x 11 in., 236 pages. Price $10.00.* The program and 28 of the papers presented at this Conference are included.

DIAMOND TOOL PATENTS II—DIAMOND ABRASIVE WHEELS. *Edited by P. Grodzinski. Published by Industrial Diamond Information Bureau, Industrial Distributors (Sales) Ltd., London, E. C. 1, 1948. Paper, 7¼ x 9¾ in., 52 pages. Price 10/-.* Lists, classifies, and abstracts about 400 British, American, German, and other patents dealing with diamond abrasive wheels.

ANALYTICAL METHODS FOR ALUMINUM ALLOYS. *Published by Aluminum Research Institute, Chicago, 1948. Fabrikoid, semi-loose-leaf form, 6 x 8¾ in., 103 pages. Price $1.00 in U.S.A.; $1.25 outside U.S.A.* Contains sections on chemical, photometric and spectrographic methods for the quantitative determination of elements commonly found in aluminum alloys as well as a section on methods for sampling ingots. These methods have been proved and tested in the laboratories of A.R.I. members.

ALUMINUM AND ITS ANODIC OXIDATION (WERKSTOFF ALUMINIUM UND SEINE ANODISCHE OXYDATION). *By Max Schenk. Published by A. Francke A.G., Berne, Switzerland, 1948. Cloth, 7 x 9¾ in., 1042 pages. Price S.Fr. 138.—(In German.)* Discusses nature and properties of aluminum and its anodic oxidation. Physical, chemical and electrochemical characteristics of aluminum alloys are given.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933 AND JULY 2, 1946

Of MATERIALS & METHODS, published monthly at New York, N. Y., for October 1, 1948.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the State and County aforesaid, personally appeared William P. Winsor, who, having been duly sworn according to law, deposes and says that he is the Publishing Director of MATERIALS & METHODS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and publishing director are: Publisher, Reinhold Publishing Corporation, 330 West 42nd St., New York, N. Y.; Editor, Fred P. Peters, 53 Meadowbrook Road, Chatham, N. J.; Managing Editor, T. C. Du Mond, 44 Fountain Place, New Rochelle, N. Y.; Publishing Director, William P. Winsor, 400 E. 52nd St., New York, N. Y.

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(signed) WILLIAM P. WINSOR,
Publishing Director.

Sworn to and subscribed before me this 13th day of September, 1948.
(My commission expires March 30, 1949.)

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Notary Public.